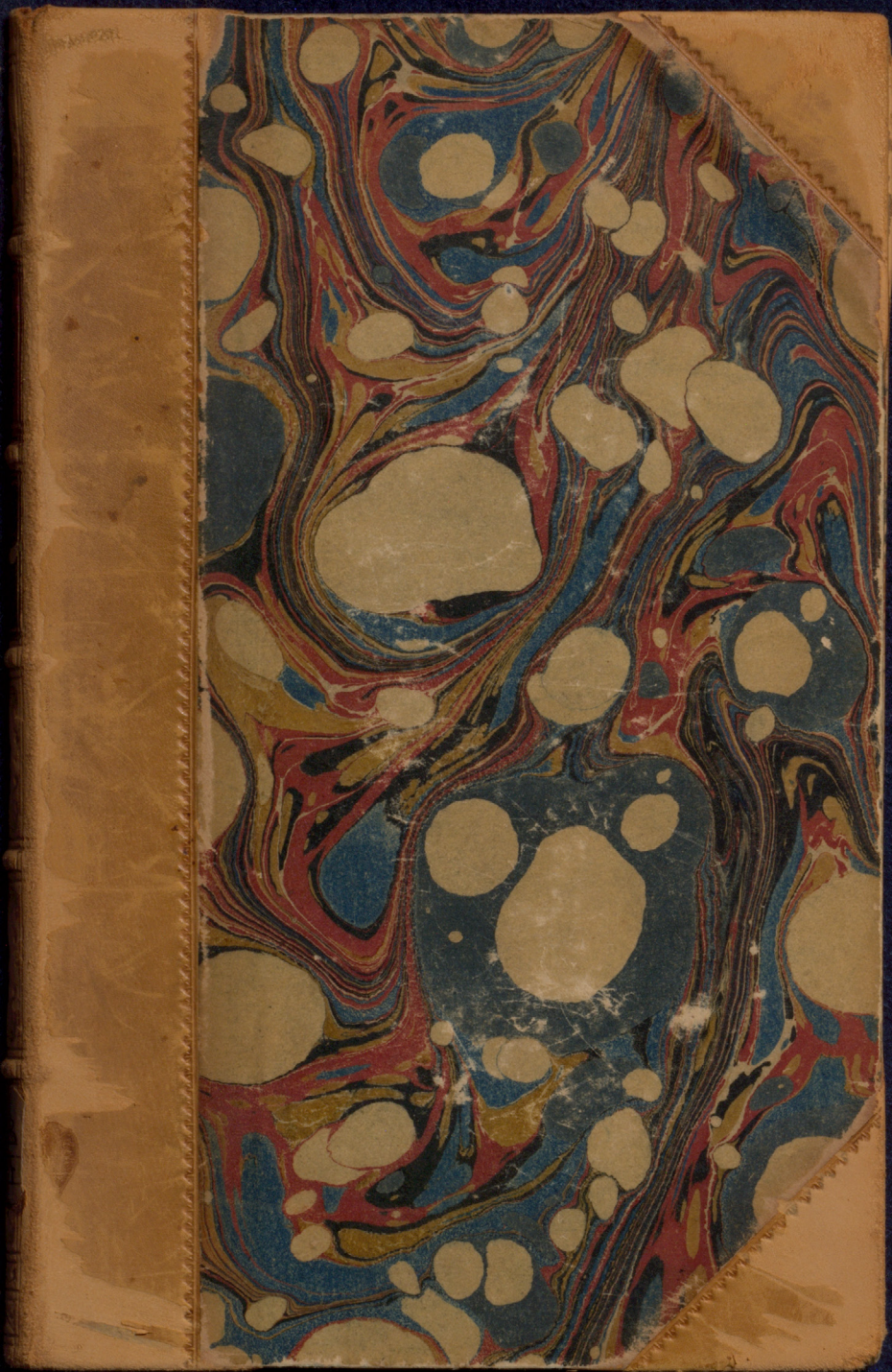




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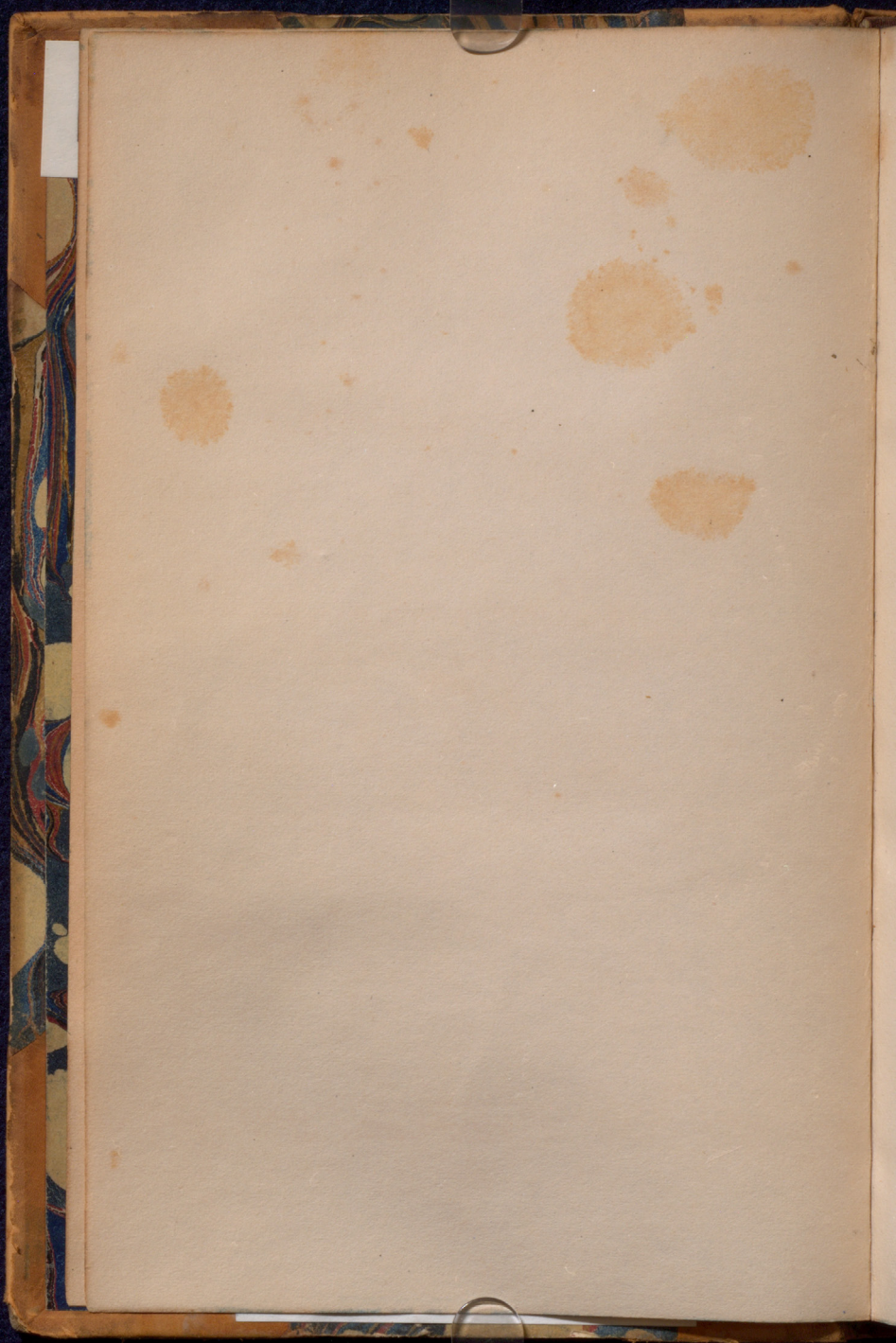
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ON
THE FUNCTIONS OF THE BRAIN
AND
OF EACH OF ITS PARTS:

WITH
OBSERVATIONS ON THE POSSIBILITY OF DETERMINING THE IN-
STINCTS, PROPENSITIES, AND TALENTS, OR THE MORAL
AND INTELLECTUAL DISPOSITIONS OF MEN AND
ANIMALS, BY THE CONFIGURATION
OF THE BRAIN AND HEAD.

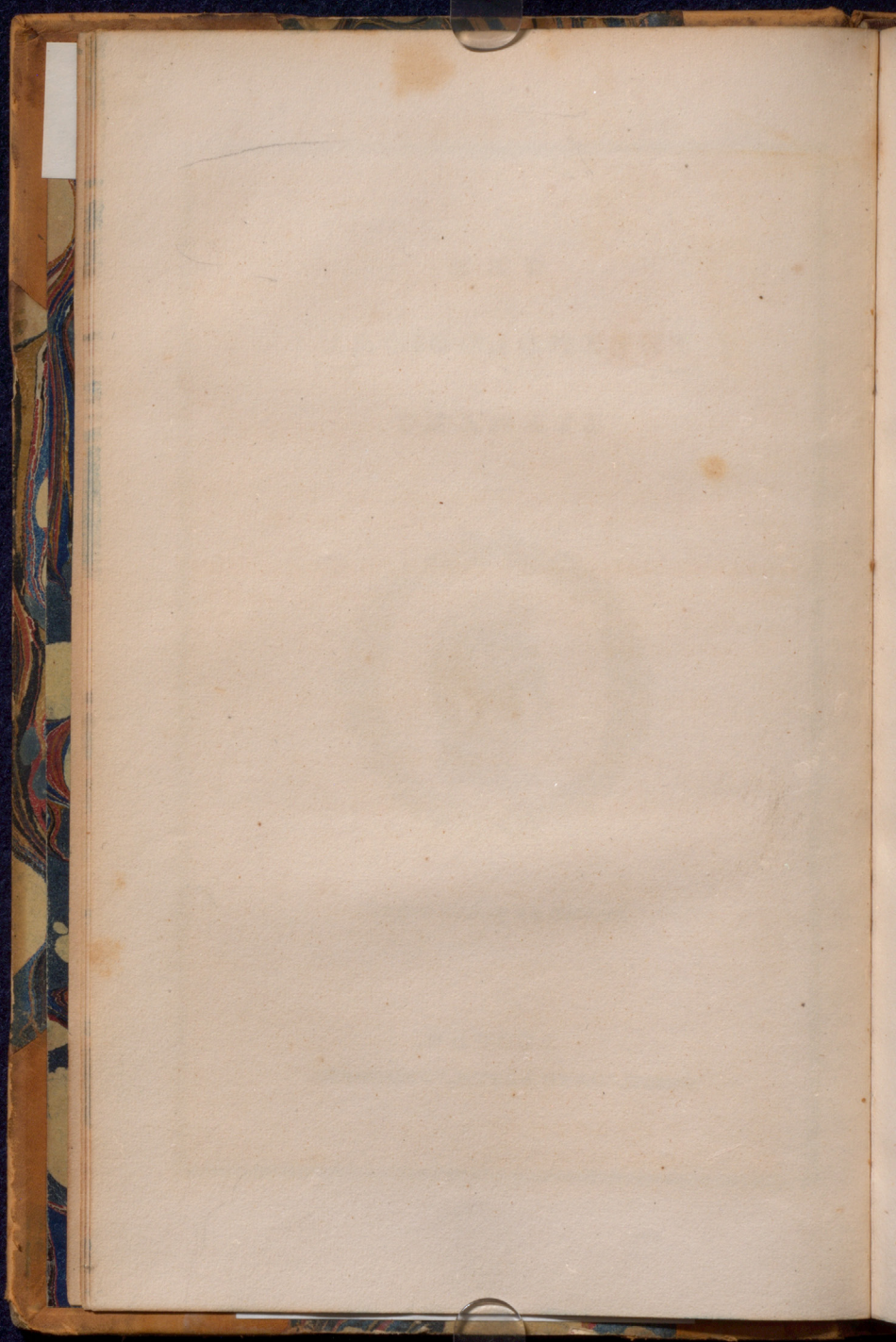
ON
THE FUNCTIONS OF THE BRAIN
AND
OF EACH OF ITS PARTS;
WITH
CONSIDERATIONS ON THE POSSIBILITY OF DETERMINING THE IN-
TENSIVE PROPERTIES AND TALENTS OF THE MIND
AND INSTINCTUAL DISPOSITIONS OF MEN AND
ANIMALS BY THE CONSIDERATION
OF THE BRAIN AND HEAD.

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BOSTON,
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CRITICAL REVIEW
OF SOME
ANATOMICO-PHYSIOLOGICAL WORKS;
WITH
AN EXPLANATION OF A NEW PHILOSOPHY
OF THE
MORAL QUALITIES AND INTELLECTUAL FACULTIES.

By FRANÇOIS JOSEPH GALL, M.D.
TRANSLATED FROM THE FRENCH
By WINSLOW LEWIS, JR., M.D., M.M.S.S.

IN SIX VOLUMES.

VOLUME VI.

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PREFACE.

HAVING omitted in this edition, the anatomy of the nervous system and of the brain, I did not intend to enter into any discussion regarding anatomical facts. But as, since my first publications, the nervous system has become the object of numerous researches, both of anatomists and physiologists, it is no longer possible to discuss its anatomy or its physiology, separately. Some maintain, that anatomical propositions are so intimately connected with physiological, that the truth or the falsehood of the former, necessarily includes the truth or the falsehood of the latter. Others, by confounding the vital with the special animal functions, pretend to have discovered the organs of the specific functions by the lesion and mutilation of the different parts of the nervous system and of the brain.

I have therefore thought it necessary to reply to the principal works, which treat promiscuously of the anatomy and physiology of the nervous system, at least so far as they are directed against my discoveries.

The works of Tiédemann, Carus, Rudolphi, Rolando, Flourens, Burdach, Serres, &c., &c., have seemed to me to be the most deserving of notice; because in them there is the most manifest intention of overthrowing my anatomical and physiological principles.

As to the comparative anatomy of the brain in the four classes of vertebrated animals, by M. Serres, I have noticed the report of it inserted in the *Archives générales de Médecine*, T. VII. 1825. At first, I supposed that the author of this report entertained the

same opinions as M. Serres; but afterwards, I saw that M. Olivier had repeated, among many other excellent remarks, several of the same observations that I myself had made against the assertions of M. Serres.

In one of the volumes, I have reproached MM. Chaussier and Adelon with having copied my ideas on the functions of the five senses, without making mention of me. It is due from me to repair the wrong which I have done to these illustrious professors; they had indicated the source of their ideas in some preceding passages.

The objections, which have been made against the physiology of the brain, since the publication of my large work, are but repetitions of those which I have so often refuted. The same may be said of those of M. Bérard, the most of which are purely metaphysical. As to the rest, his doctrine of the relations of physics and morals is a forced work of circumstances, and is consequently unworthy of the serious attention of an observer of the constant laws of nature.

I have always had a consciousness of the dignity of my researches, and of the extended influence, which my doctrine will hereafter exercise on all the branches of human knowledge; and, for this reason, I remain indifferent to all that may be said, either for or against my works. They differed too much from the received ideas of the times to be appreciated and approved at first. It required a profound and connected study to understand them: all the world, however, wishes to judge, and each one gives his opinions according to the degree of his intelligence.

My whole doctrine is now before the public. The decision cannot remain doubtful much longer. Personal considerations will disappear; the passions will be calmed, and the critic will judge of it only by its intrinsic value. Posterity will not fail to establish a parallel between the point whence I started, and the place to which I have arrived. Opponents have too well shown the state in which the different objects,

which make a part of my works were found, to make it difficult to determine the advances they have made or will make by my discoveries.

What advances in comparative anatomy, physiology, and comparative pathology of the nervous system! What fruitful source of undeniable principles for philosophical studies, for the art of selecting, deducing the good from the dispositions of individuals, for directing the education of the young! What precious materials for a criminal legislation, founded upon a complete knowledge of the motives of human actions! How different will history appear to him, who knows how to appreciate it, according to the dominant propensities and faculties of those personages, who have been its great actors, &c. &c.

The foundation of this useful doctrine is established, and it should be as firm as the facts, the materials of which it is constructed. But I am far from believing that the edifice is finished! Neither the life, nor fortune of one man, can be sufficient for this vast project. Hitherto I have depended on my own resources. But an immense number of fortunate circumstances must concur, in order to elevate this study to the degree of perfection of which it is susceptible. It is necessary to have a complete collection of the skulls of animals, not only of various species, but also of individuals in whom had been recognised faculties or qualities particularly distinct: there should be a complete collection of the brains of animals, modelled after nature in wax, in order to increase the means of comparison. A large number of skulls, or at least of busts moulded in plaster, of men and women distinguished for some quality or faculty, are also requisite: and lastly we should possess a more extensive acquaintance with natural history than we do at present, as regards the instincts, mechanical aptitudes, the qualities and faculties; in a word, as to the interior economy of animals.

It is to be hoped, that the utility and importance of

these researches may soon be generally acknowledged; that soon a necessity will be felt of making it an object of public instruction; that governments themselves will favor it; that others among the learned will assist me with their knowledge, and that then moral and intellectual physiology will appear in a splendor, that my unaided efforts could not alone effect.

I had contemplated making extracts from the English works of Mr. Combe, and from the various societies which have been formed in London, Edinburgh, Philadelphia, &c. But those works are too important to be given in the small space, which I could devote to them; nor would such abstracts have been satisfactory to my readers. Those, who read English and are interested in the physiology of the brain, will be readily convinced how much those men have contributed to its perfection.

At the time when this volume was nearly finished, a young and very skilful anatomist, M. Fauville, thought he could refute my ideas on the origin of the white fibrous substance, on the double converging and diverging system in the brain, and on the formation of the great commissure of the hemispheres. His mode of observation differs from that of M. Tiédemann, and his anatomical preparations really present a great degree of plausibility, so that those who are not familiar with the anatomy of this organ, so delicate and complicated, or those who cannot receive physiological proofs, may easily be persuaded, that the great commissure is the immediate continuation of the fibres of the corpora striata. It is for this reason, that I shall present in a single point of view, the principal arguments which prove, that the great commissure is formed by the nervous fibrils reëntering from the surface of the diverging and converging convolutions, to form this great union of the hemispheres. But the importance of these proofs will not be perceived, until the reader shall have read what I have said on this subject in the course of this volume.

I. It is evident to the eye, that the transverse bundles of the annular protuberance, or of the commissure of the hemispheres of the cerebellum, are continuations of the nervous fibrils, which arise from the surface of the lamellæ of the cerebellum, and which, by converging and uniting to those of the opposite side, form this commissure.

II. It is also in the same manner evident, that the anterior commissure is formed by the fibrils and bundles, which converge from the anterior interior part of the middle lobes. The great nervous cord traverses the corpora striata, without adhering to them in any way. Indeed, if any commissure is to be formed by the bundles of the corpora striata, it must be this one.

III. The septum lucidum, equally formed by the nervous fibrils which come from the base of the brain, and which meet in the median line of the great commissure, is but a commissure, and has nothing in common with the corpora striata.

IV. The posterior pillars of the fornix and the lyra are the result of filaments, entering and coming out of the fimbriated edge of the tœnia, and the cornu Ammonis. All these parts have no connexion with the corpora striata, but yet make a part of the great commissure.

V. No one will contend, that the anterior and posterior folds are not integrant parts of the great commissure. Now, these folds are evidently formed by the nervous fibres, which reënter converging from the anterior and posterior lobes of the hemispheres. The direction of the fibres which form these folds, is evidently opposed to the direction of the nervous bundles of the corpora striata. It is impossible to conceive this disposition, if it is admitted that the fibres of the folds are continuations of the corpora striata; every thing, on the contrary, is explained by allowing that the folds are formed by the reëntering

fibres of the hemispheres. Their direction, which is oblique and crossing that of the bundles of the corpora striata, is necessarily controlled by the width of the interrupted horizontal direction of the anterior and posterior lobes of the hemispheres. If, then, the septum lucidum, the posterior pillars, the lyra, the posterior and anterior folds, all the integrant parts of the great commissure, are formed by the reëntering fibres of the hemispheres; if all the other commissures, that of the hemispheres, of the cerebellum, the anterior commissure, are formed by the reëntering or converging fibres of the hemispheres, how can any one rationally admit, that the only middle horizontal part of the great commissure should make an exception to this general law?

VI. The great commissure, in its posterior part, is extended beyond the corpora striata, because the posterior lobes are more voluminous than the anterior, and it is the posterior lobes, which furnish the posterior third of the great commissure. If this posterior third were a continuation of the corpora striata, it could not be extended backward farther than the corpora striata themselves.

VII. The fibres of the corpora striata diverge more and more, as they proceed from their origin. This divergency ought to be perceptible in the fibres of the great commissure, even as far as its median line; but, commencing from the two folds, the direction of all the fibres of this commissure is perfectly parallel, as far as to their reunion in the median line; no tendency to divergency can be discovered. This tendency should be more perceptible towards the anterior and posterior thirds of the commissure.

VIII. The fibres of the bundles of the corpora striata are stronger and of a firmer consistence; those of the great commissure are more delicate and softer.

IX. In the fœtus, the great commissure is formed from before backwards, for the anterior lobes are the

first to appear. If it were the continuation of the corpora striata, it should, like those bodies, be formed from behind forward. They exist even when there is no appearance of the great commissure; while, on the contrary, this commissure commences at the same time with the hemispheres.

X. The two folds being thicker than the rest of the great commissure, evidently prove, that they have gained an increase of medullary fibres, which cannot be conceived on the supposition, that they are the continuation of the corpora striata.

XI. The posterior fold is much thicker and more furnished with nervous fibrils, than the anterior. This fact is explained by the greater volume of the posterior lobes, which consequently furnish a greater number of fibrils to form this fold. If the two folds were a continuation of the corpora striata, this difference of thickness could not be accounted for.

XII. For a long time, anatomists could not explain the great quantity of the white substance of the hemispheres, by the bundles of the corpora striata only. But this increase of the white substance is conceivable, when it is admitted, that the grey substance of the surface of the hemispheres, furnishes the other half of it. And as throughout, the grey substance produces the nervous fibrils, it is conformable to the universality and constancy of the laws of organization, that the same should be true of the grey substance, which is not fibrous, which covers the external surface of the cerebral membrane.

XIII. Lastly, if the great commissure were a continuation of the corpora striata, it would be impossible to explain phenomena seen in hydrocephalous subjects, as the unfolding of the hemispheres, their extension into a large bladder, without any rupture, and often without any remarkable injury of the functions of the brain.

These arguments henceforth ought to be sufficient

to demonstrate the weakness of the attempts of certain anatomists, to deny the reëntering converging system, and the formation of the great commissure agreeably to it.

FUNCTIONS OF THE BRAIN.

THE ANATOMY OF THE BRAIN, *containing the History of its Development in the Fœtus, with a comparative Exposition of its Structure in Animals*: by FREDERIC TIEDEMANN, &c.: Translated from the German by A. J. L. JOURDAN. Paris, 1823.

M. JOURDAN has prefixed to his translation a preliminary discourse, and M. Boisseau, in the *Journal Universel des Sciences Medicales*, Vol. xxx. p. 309, has complimented both. It is asserted by these learned writers, that the observations of Tiédemann have refuted the principles, established in my anatomy and physiology of the nervous system in general, and of the brain in particular. Before examining the works of Tiédemann, I shall review the preliminary discourse of Jourdan, and the report of Boisseau.

Jourdan commences by proving, that he is initiated in the mysteries of the transcendental philosophy. He tells us, that it is impossible to conceive the idea of absolutely inert matter; that activity alone exists for the idealist as well as for the realist: in a simple state for the first, who allows but one power, the *me* (*le moi*); double for the second, which supposes two, the *me* and the *not me* (*le moi et le non moi*); that to feel is to be sensible to a power, which fills a certain space; that the universe, as cognizable to our senses, has its origin in the conflict of an infinity of different

powers; that Kant has satisfactorily demonstrated, that both space and time, are the primitive forms of all intuition; that the words *body* and *force* express only one and the same idea, as we particularly regard its existence, either in space or time; that consequently, *to be* and *to act* are synonymous terms; that very many absurd theories, &c., would have been avoided, if physiologists, true to the wise precept of Hippocrates, had borrowed from philosophy the art of reasoning only; that the words *organization* and *life, organ* and *organic action*, express the same phenomenon, according as the one or the other is considered as acting, or as existing, or as to space or time, &c., &c.

Jourdan afterwards makes an application of these profound speculations, to the physiology of the brain, in his opinion a judicious one, in mine erroneous. After having examined many errors of the philosophers, he considers with Seneca and our own experience, that man has a greater tendency to believe on the faith of another, than to examine and judge for himself. He moreover discovers, that many cerebral parts are but little developed in some animals, whose cerebral action differs but little from that, which is seen in other animals, who have them very large; that the preëminence of man, as to cerebral action, depends not on the presence of a new part, but on the development, and more especially on the concentration (*centralization*) of those, which exist already in the lower classes of animals; that the soul is the highest degree of perfection as to sensibility, that is to say, of the nervous action itself; the active manifestation of a nervous system perfectly centralized, (*centralisé*,) having for its result the development of individual consciousness, as this perfectly centralized system is but the soul itself, considered only as regards its existence in space; that this doctrine accords with the immortality of the soul; that the brain acts in time, without simultaneously manifesting itself in space; that we cannot perfectly understand it, because it is

not restricted to the two primitive and necessary forms of all intuition by our intelligence. "As it does not manifest itself to us," continues Jourdan, "in space, or under either of those two forms, which alone can affect our external senses, we can only acquire a confused notion of it by our internal senses. But, although this notion may be confused, it does not necessarily follow, that it should be erroneous. Therefore," adds Jourdan, "in my opinion, we may, by the light of reason alone, arrive at an intuition of existence purely intellectual in all nature, of a principle superior to matter, the bonds of which there is so great a tendency in us to separate. It seems to me, then, that we arrive at a certain point in conceiving intelligence as the product of centralization of a nervous system, whose sphere of action augments as the more intimate harmony is established between its different parts. In this way, a superior man disseminates the influence of his genius, and extends its power over vulgar minds, which it subjects to its control. Thence arises the force of opinion, that immovable rock which withstands all the effects of physical might, of that opinion which made Tiberius tremble in the midst of his satellites, and in those recesses where he had shrouded his crimes and his fears."

It is in this manner, that Jourdan wishes psychology to be regarded, and his whole preliminary discourse abounds with such incoherences, such exquisite taste, such sublime thoughts, such connected ideas, such severe judgments, &c. But the intelligent principle of Jourdan is not exhausted by these efforts. He resorts to Kantism, and whether he talks sense or nonsense, I am ready to respond for his entire innocence; and I shall now show how, by the most singular evasions, he comes to his principal point, the refutation of my physiology of the brain.

"The doctrine of the plurality of the faculties, and consequently of the cerebral organs, is in my mind inadmissible. It is denied, from a false application of

the principle, that one organ cannot, at the same time, perform many offices."

The doctrine of the plurality of the faculties is not deduced from any principle; it is the result of observation only; it is the observation of the diversity of instincts, propensities, and talents of men and of animals; the observation, so confirmed and constant, of the exterior indications corresponding to the varied forms of brains, which has confirmed the belief, that the various parts of the brain are appropriated to the different faculties! If Jourdan reads my works, he will there find, in a thousand instances, these same proofs, and no longer be disposed to judge a cause before knowing its merits.

Jourdan reproduces all the objections, which he might have found answered in my writings.

Thus he says: "We cannot perceive any real difference between the objects, designated by Gall as fundamental faculties. They are the developments of the same activity, dependent on the perfection of the brain, or, in other words, on the addition, not of new parts, but on an increased quantity of cerebral substance."

According to the transcendental philosophy, the functions of the various senses are only modifications of one and the same sensibility. Nevertheless, nature has given a different nervous apparatus for each of these functions. If Jourdan finds no real distinction between the talent of poetry and the propensity to propagation, between the memory of places and the genius of induction, between the talent of music and that of construction, how can he explain why the monkey and the goat do not compose poems? why the swallow and the stork are not philosophers? or why the hog cannot sing like the nightingale? All these ideas being fully refuted in my works, it is useless to enlarge at this time upon the subject.

The *centralization* of the brain has become the favorite theory of Jourdan, Bérard, and their associates. It is

unfortunate for French glory, that this is not of French French origin. How! so sublime a discovery, so fruitful in results, and sprung from a foreign soil! Jourdan, Bérard, and their associates, have borrowed it from Carus, Carus from Okem, and all the transcendental metaphysicians of Germany have conceived it *à priori* in their sublime constructions of the universe. Let us unite our efforts, to transplant these brilliant discoveries to the schools of Paris and Montpellier. Why should they any longer trouble themselves to find the measure of intelligence in each species of animals, and in each individual? By a happy idea, the mass of all the faculties is thrown into the same bony boxes (*boîtes*). Weigh the contents of these boxes, weigh the brains, and you will have the intelligence of a grain, of an ounce, from one to three pounds, six pounds, always in the proportion of the cerebral parts centralized to one simple mass, equally uniform as to its existence, as to its dynamic activity, its existence in space, and its activity in time. It is, therefore, no longer a question but of the *plus* or *minus*, and the *minus* or *plus*.

The carp will build somewhat like the beaver, and the beaver will build at least a thousand times better than the bee; the sheep will kill as much as the wolf, and the elephant will be twenty times more murderous than the tiger; the frog will sing like the nightingale, which will be two thousand times surpassed by the wild boar; the dolphins and porpoises will make as much better philosophy than Jourdan and Bérard, as the centralized mass of the brain of these learned men, is exceeded by the cerebral mass of these metaphysicians of the ocean.

As to the passage which Jourdan quotes from the work of Georget, I have also done the same, and replied to it in the fifth volume of the octavo edition, p. 523.

"Add to these difficulties," continues Jourdan, "those which are presented by the limitation of dis-

ting faculties in the midst of a mass, whose substance is every where continuous." An objection, which Jourdan will find answered in vol. II. pages 380, 383, and 391.

According to Jourdan, the objections are increased, in proportion as the hypothesis of the plurality of the cerebral organs, is taken into consideration, without mentioning the discordance between Gall and Spurzheim, the first of whom counts but twenty-seven organs, while the latter admits thirty-five.

Neither Spurzheim nor myself have ever definitely limited the number of organs; we both agree as to those we have both admitted; and if, at some future time, Jourdan should discover a new organ, by observations founded on a great number of positive facts, and on comparative anatomy and physiology, he will have the merit of having added to the perfection of the physiology of the brain. Here again, I refer him to some late details in my works, and more especially to vol. III. page 15, 4to. edition.

"It is necessary only to examine without prejudice each of these pretended faculties, to discover that they are all very complicated, whereas a faculty should be simple." Indeed, if you decide the faculty of the instinct of propagation, the love of offspring, of attachment, of self-defence, to be all one faculty, then you have faculties very complicated. All that Jourdan says of the instinct of self-preservation, of the propensity to govern, of the love of glory, is but the repetition of the same ideas which have been refuted in each treatise on a fundamental faculty, and, in particular, in the replies made to the objections of Demangéon. The views of Lamarck regarding habit, have been more amply discussed than they merit, in vol. I. p. 155.

As to the results of education, which Jourdan but so imperfectly understands, in case our faculties were real, how can he understand that the eyes of the painter, the ears of the musician, the tongue

of the wine-taster, receive an education? The sight, the hearing, the taste, are not these real faculties?

"In surveying the long series of animals provided with a brain," M. Jourdan says, "we observe the circle of the intellectual faculties increase, in proportion as the hemispheres of the brain advance towards the cerebellum, which in man finally terminate by covering it entirely. Is it then credible, that the anterior part of these same hemispheres, has the privilege of concentrating in itself the most noble prerogatives of intelligence; since this part is that which is the first developed? And without attaching more importance to the posterior than to the anterior lobes, is it not exceedingly probable, even certain, that their appearance is connected with the most complete development of the encephalon, and consequently of the mind; since otherwise it would have been sufficient to produce a more extended intelligence, to have given to the anterior lobes alone a greater amplitude or thickness?"

This objection proves, as M. Jourdan says, that man has a greater tendency to believe on the faith of another, than to examine and judge for himself. When on the subject of the love of offspring, I demonstrated, that it was not true, that the posterior lobes were wanting in animals, which, as regards intelligence, are placed below man. Many animals, as the elephant, the dolphin, and apes, have the cerebellum as much covered by the posterior lobes, as man. I have shown, that this error of Cuvier, Tiédemann, and Carus, has its source in the position more or less horizontal or vertical in animals. In all females, the posterior lobes are more developed, more completely covering the cerebellum, than in males. From this, it should follow, that women excel men as to the noblest faculties of the intellect. If I desired to reason on this point, I should say, that the posterior lobes, as well as the cerebellum, were developed at a later period, because they are the organs of propensities, which are manifested much later in life, than the faculties of

intelligence. If M. Jourdan could be persuaded to read, what I have said upon the signification of a large or small development of the forehead, he would be convinced, that he never would have made this objection, if he had known my works. It is rather a great part of the middle lobes, which are wanting in herbivorous animals, as I have demonstrated by comparing the brain of a calf with that of a carnivorous animal. Vol. iv. p. 76.

"If we pass," continues M. Jourdan, "to other difficulties, our doubts will still increase. Let us admit for a moment, the opinion of Gall as to the structure of the convolutions, *although it may be apparent at this day*, that it is false and founded in a great measure on an erroneous theory of the hydrocephalus internus: we must then attribute different faculties, either to various parts of the length of the same fibre, or to the bundles made up of these fibres. The absurdity of the first supposition is very evident. [Why does M. Jourdan concern himself so much with mere absurd propositions?] As to the second, how is it credible that fibres of the same nature, which arise from the same point, which are in contact and are even intimately united with each other, can possess different faculties?"

If the first supposition were absurd, the second is false, as I have fully shown in many parts of my works. To recall to the reader one of these replies, is it not true, that, in the medulla oblongata, the different fibres and ganglia appear of the same nature, that they arise from the same point; (if M. Jourdan wishes to designate as a point a considerable extended space,) that these fibres touch each other, and that they are there as intimately united as in any other part of the brain, and that still they possess different faculties? Nothing is more unaccountable, than what MM. Jourdan and Bérard say of the structure of the brain. At every moment they betray the fact, that they have never dissected, nor witnessed a dissection of this

organ. Where is then this same point, from which the nervous fibrils of the hemispheres arise? Have they ever seen the hemispheres unfolded, that they dare to assert, that my opinion of their structure is false? Have they ever examined a hydrocephalic subject, where the brain has been found dissolved, instead of being unfolded? It must result from a total ignorance of all these physiological and pathological phenomena, that any one can still uphold the ancient errors with such conceited vanity.

"It is the development of this or that convolution," continues our learned M. Jourdan, "which builds up each faculty, as Gall says. But the beaver possesses to an high degree the talent for architecture, notwithstanding his brain is perfectly smooth; whilst the seal, whose hemispheres are furnished with convolutions nearly as numerous as those of man, manifests no capacity as to ingenuity or construction. Moreover, the beaver loses his constructive talent, as soon as he quits the society of his species. There is then something besides the greater or less development of this or that portion of the encephalon, which is the foundation of the propensities and talents of man, and animals provided with a centralized nervous system. I have added this last phrase intentionally, for it appears to me incontrovertible, that the propensities and talents are both connected with a special organization, when the nervous apparatus is composed of masses either insulated or feebly united, while, at the period when this same apparatus has acquired a marked influence over all the others, its action also assumes a character of unity, which permits the predominance of a propensity or talent, only inasmuch as it has in itself more or less preponderance. Intelligence is not the noblest attribute of cerebral action, as has been said, but it is that free will, by which the highest degree of volition is manifested, and which exacts the most perfect development and centralization of the nervous system. I defy M. Jourdan to give any

rational interpretation of all the arbitrary expressions, the half anatomical, half metaphysical nonsense of the last passage. Let him first explain to me how the beaver, who, according to his statement, is still deficient in the convolutions, possesses to such a great degree the talent of architecture, whilst the seal, whose hemispheres have so many convolutions, even more numerous than man, does not manifest any capacity for mechanical ingenuity and construction; while man so often shows a passion for the mechanic arts. According to the hypothesis of the centralization, the seal should enjoy all the faculties. Some one has told M. Jourdan, that the brains of the rodentia have no convolutions, and he has believed it without further examination. If he had ever observed the brain of the beaver, of the kangaroo, and of many others of the rodentia, he would have found these convolutions; and if he had ever seen beavers when alone in a small pond, he would have learned that they do not lose that talent, which, by his statement, revives immediately when they are in company with their species. All animals in a state of captivity or wounded, suspend, at least for a short time, the exercise of their faculties, but they do not lose them. If M. Jourdan had read my works, he would have found the reply to this objection, vol. iv. p. 145.

The following is a similar fact that M. Geoffroy Saint Hilaire has had the kindness to communicate to me.

"There has been at the Menagerie du Jardin du Roi, for several years, a beaver. He is not of the social species like the beaver from North America, he is of the species of beaver of the Rhone, who live alone like water rats. Nevertheless, after what I have witnessed, it is evident that animals, when constrained by a new position, can find in their native qualities resources, which they can oppose to unexpected contingences.

"Our beaver at the Menagerie occupied an apartment which was never warmed. In the winter

season he was furnished with an abundance of straw, and a shutter was prepared to enclose the bars of his apartment. It happened that, one night, it was excessively cold: the shutters were not made tight, and the beaver endeavoured to obviate the effects of the severe weather by all the means in his power.

"It was customary to give him at night a certain quantity of fresh branches for food. In the morning the wood was found divested of its bark. Before closing him up by letting down the shutter, they gave him in the evening fruit, carrots, apples, &c.

"It had snowed, and the snow had accumulated in a corner of his apartment.

"These were all the materials, which the beaver had to make use of, to build up a wall to defend him from the cold and the external air.

"He twisted the branches of the tree among the bars of his cell. This was done precisely like basket work and with great symmetry. The branches thus interlaced, of course left little spaces which the beaver filled up with the carrots, apples, and straw. Each of these was cut, so as to correspond to the opening which it was required to close: and lastly, as if the animal had comprehended the necessity of covering it all with a more compact cement, he used the snow to fill the very minute spaces. The wall protected two thirds of the aperture, and he used all that had been given him in constructing it.

"It happened in the morning, that the snow, being frozen between the branches and the side of the shutter, the last adhered to the newly built wall. The shutter, however, being raised, disclosed in this manner, the wall which had been built by the beaver.

"The attendant was so astonished at this unexpected construction, that he came to me immediately without having deranged it.

"In stating the above to Dr. Gall, I have only given that which I witnessed myself."

If M. Jourdan had had even the most superficial

knowledge of the physiology of the brain, he would not have said that this or that convolution established this or that faculty. He would have said, that such a cerebral part is the organ of such a faculty, and that this faculty is the more energetic, as this cerebral part, whether it be smooth or folded into convolutions, is the more developed.

Let M. Jourdan point out to me the animals, who are provided with a *centralized* nervous system. I designedly use this term. At what period can one admit, that the cerebral parts are still enough isolated, in order that each should be connected to a special function? What is the extent of this isolation? At what distance should the nervous bundles be separated from each other? Are they sufficiently so in the medulla oblongata, in the annular protuberance, where no distinct separation is perceptible, and whose functions are so different? or are they centralized, as the advocates of centralization suppose? In what species of animals does this centralization commence? How happens it, that in man, in whom, according to your notion, this centralization is the most perfect, there is, in almost every individual, some propensity or talent, which predominates? Great architects, musicians, mathematicians, poets, voluptuaries, philosophers, &c., have then the misfortune of not possessing a centralized brain!

And as to the brains of porpoises and of elephants? let M. Jourdan show me there, the difference between them and that of man! Why do not these animals enjoy in the highest degree the self will of M. Jourdan? Centralization then is a word without sense, not founded on fact, a chimera, a monstrous offspring of the transcendental philosophy, begotten and adopted by Messrs. Jourdan, Bérard, and company, to serve them as a defence against the irresistible proofs of the plurality of the cerebral organs.

We come, at last, to the definitive judgment of M. Jourdan, as to the physiology of the brain. "If I

reject," he says, "the doctrine of the plurality of the intellectual faculties and the cerebral organs, which appears to me untenable, I do not think that there exists, even in man himself, various degrees of intelligence, corresponding to as many conditions of the brain, which produce marks of their existence on the skull, and of which the *general* form of the cranium becomes a sufficiently accurate index."

Is it to be credited, that this avowal has been drawn from M. Jourdan, from a slight attention to the different forms of the crania of men endowed with various degrees of intelligence? This redoubtable adversary understands German, and has read the concluding pages of M. Carus, from 310 to 311, which he has faithfully copied, without making the least mention of M. Carus. In the poverty of his resources, and in the security that few of his countrymen would detect his plagiarisms, he is modest enough to make a display, even of the very blunders of another. He continues, by making use of the passage from M. C. J. Carus. "But I am persuaded also, that it is with craniology as with physiognomy; and as it would be absurd to attribute idiocy to large lips or to a prominent chin, because these are often observed in the physiognomy of persons of dull minds, it is not less so to connect different degrees of intelligence with any prominence of the encephalon and its osseous covering, which, perhaps, may be noticed in a certain number of individuals, who might possess it in a degree more or less remarkable. The doctrines of Lavater and Gall rest on the same foundation, on a *petitio principii*: they must share a similar fate. We are authorized in the belief, that, as there exist in the human race as many modifications as individuals, and as the different degrees of organization remind us of those cases in which nature established, and permanently adopted in some of the inferior vertebrated animals, the general formation of the human head, should express a character resembling that, which is found in

these same animals, according as the cerebral organization, or, which is the same thing, the intellectual dispositions of the individuals, approach those which characterize them. It was in this light, that Porta* wished physiognomy to be considered, and certainly it would be more profitable in the results than the arbitrary methods of Lavater and Gall."

Here is an eminent example, where it may be well said, that the dead destroy the living. Whenever I shall wish to be admired, extolled, and even have my follies applauded, I will drown, hang, burn myself, to ensure death; and if, notwithstanding these means of destruction, my *moi* remains still condemned to employ itself in the affairs of my *non moi*, with the inanities of the world in *space*, I wish, at least, to have places and titles to bestow in *time*.

I have read both Porta and Huart.† I earnestly wish that M. Jourdan should enrich French literature with those interesting productions. They are embellished with engravings, which are very convincing of the truth of the physiologico-physiognomical principles, such as human heads of both sexes, with the jaws and ears of an ass, and foreheads like the Spanish rams, &c., &c. We read, (the page I cannot now recollect): "Those, whose foreheads are retreating, compressed, narrow, and similar to the vilest ape, are wicked, perfidious, mimics, liars, boisterous: those, with the beak of a magpie, are thieves, plagiarists, boasters: those, with large eyes and round ears, resemble rats, and are compilers: those, with sharp noses and scarcely any eyes, like the mole, they are taciturn and act by stealth." And an infinity of such things are found in those authors, equally worthy the consideration of our most renowned physiologists. I cannot conceive how I

* *De humanâ physiognomoniâ*, B. Portæ Neapolitani; lib. iv. qui ab externis, quæ in hominum corporibus conspiciuntur signis, ita eorum naturas, mores, et consilia demonstrant, ut intimos animi recessus penetrare videantur. Haver, 1593. (*Note by M. Carus.*)

† Über die Prüfung der Köpfe.

could so far have forgotten the previous lessons of Porta and Huart, as to have written in vol. iv. p. 284, of my large work, and vol. v. p. 429, of the octavo edition, a treatise on physiognomy and pathognomy, in which I have urged the absurd idea, that there is some difference between the signification of an aquiline or flat nose, large or contracted lips, and a defect or development of a part of the brain: lips impart to us the delights of a kiss; all the world is aware of the great advantage of a nose; but of what use is the cerebrum and cerebellum? at most, (the discoveries of the new physiology lead to that belief,) but to serve to make the miserable race of man walk forward or backward.*

Journal Universel des Sciences Medicales, vol. xxx.
p. 309.

Let us now attend to the opinion of M. Boisseau, on the work of M. Tiédemann, and the preliminary discourse of M. Jourdan.

M. Boisseau says, p. 311: "In reading the work of M. Tiédemann, published in 1816, we shall be astonished, undoubtedly, to find in it a remarkable resemblance to the work of M. Serres, announced since 1822, at least judging of it from the report of the illustrious perpetual Secretary of the Royal Academy of Sciences. We make this remark the more willingly, because no one will deduce from it any conclusion unfavorable to M. Tiédemann, who could not foresee, who could not anticipate, (as it is now seven years since,) that that, which he had discovered already, would be, some years after, discovered by one of our associates."

When nations make war, pillage is justifiable. Now

* The discoveries of the functions of the cerebrum and cerebellum, are well known, viz. that the first is destined to make the animal walk forwards, and the last backwards.

the learned, who are bent on discoveries, are constantly at warfare with each other; therefore, they should have the right of plunder, and, in this respect, the low malice of M. Boisseau is truly national.

It matters not, whether it is M. Tiédemann who has plundered M. Serres, or M. Serres, M. Tiédemann, or M. Tiédemann, M. Carus, or Messrs. Carus and Tiédemann, Messrs. Gall and Spurzheim; the facts remain; the world, the common country of the learned, loses nothing. It is thus, that a few years before the publication of my large work, I taught in my lectures, that, according to a great number of experiments, the medullary fibres, remounting from the genital parts along the spinal marrow, as far as the cerebellum, decussate like the anterior pyramids. I have recorded those same observations and the same deduction, in the third volume, p. 115, in 4to., printed in 1818. Since the end of September, 1823, Messrs. Serres and Flourens have disputed the priority of this discovery. It then follows, that I have seized the property of these two experimenters. My criminality has been known to them for several years; for, M. Flourens has himself inserted some articles on this same work, in the *Revue Encyclopédique*, September, 1819, and March, 1820. But, instead of finding fault with me, they have substituted another purloiner instead, who has been, at least, two hundred years guilty of non-appearance. The most of those authors, who have written since the publication of my works, and who have treated of the same subjects, have exercised the same kindness towards me.

M. Boisseau cites a few anatomical facts, some of which accord with my views, and others are in opposition. I shall reply to them all, after having first explained the ideas of M. Boisseau, who continues:

"The reader will not do justice to the merit of the work of M. Tiédemann, from so slight a sketch; he has only seen, that, to judge of the anatomical system of M. Gall, it is necessary to be acquainted with the

labors of his celebrated associate. M. Tiédemann endeavours to refute it in many particulars by facts, which overthrow his principal anatomical propositions ; it is known that, unhappily for his physiological opinions, M. Gall pretends, that both are so connected, that the first cannot be refuted without destroying the last. It is for him to defend himself against an attack directed to the very foundation of his doctrine ; it is surprising, that, since 1816, he has not attempted it, and more astonishing, that, in 1817, the work of M. Tiédemann was known in France, by an analysis of M. Jourdan, in this journal. The author announces that he has the brains of fœtuses of every period, to convince, if necessary, those who might be incredulous of what he has advanced. 'I think,' says he, 'this method indispensable at a period, when, unhappily, things are described and figured, of which nature never has furnished a model.' We agree with the translator, that the work of M. Tiédemann is one of the most remarkable which has appeared for a long time ; uniting it with that of M. Chaussier, on the encephalon of the adult, it forms an anatomical monograph of the human brain."

This passage gives me an opportunity to make several elucidations, which I will render at the same time instructive. To judge correctly of my anatomical system, it is proper to know the excellent work of M. Tiédemann ; it is well to know also the works of all those, who have written and are writing on the same subject ; it is, above all, indispensable to understand my method of examining the brain, and my discoveries. But it is not sufficient to know, that one author says no, or that his predecessor has said yes. If individual authority is to determine it, I think myself as much entitled to this right, as any one else. No one has examined so many brains as M. Spurzheim and myself. All our predecessors sliced this noble organ into a thousand pieces, and were satisfied with making mechanical and minute descriptions of its different

parts. I put myself above all authority. I have broken the ice, and have established a method of philosophical and physiological dissection, founded on the gradual perfection of animals, and on the laws of the organization of the nervous system. Every day experience proves that, whenever this method is abandoned, uncertainty and error are the sure results. At one time, for example, a part derives its origin from a superior part, and is directed towards an inferior part; at another time, the reverse. Sometimes, the ganglia are simple enlargements, at another, they are the apparatus of reinforcement; now these same ganglia are placed at the commencement of the nervous apparatus; at another, they form their completion; sometimes, the gelatinous, or non-fibrous substance, gives origin to the white fibrous substance; and sometimes, this has an independent origin, &c. &c.

We have repeated the same experiment hundreds of times, to dispel the doubts which still remained in our minds; while M. Tiédemann, according to his confession, has only made his dissections on the same object two or three times. And when, after multiplied examinations, we could not sustain a particular opinion, we have frankly avowed it. Lastly, those only, who have never made examinations of brains, cannot believe, that a certain preparation, such as the maceration in alcohol, the boiling in oil, can render the parts so distinct, that the anatomist can trace, without interruption and without rupture, the origin, continuation, reinforcement, the peripheric termination, or final distribution of the nervous fibrils. I shall prove, that M. Tiédemann is often mistaken, even in things the most distinct, and that very often he has determined with precipitation, points, which apparently will for ever remain undecided. Is it, then, astonishing, that he reproaches us with having described and figured things of which nature never furnished the model? He says, to prove the accuracy of what he advances, he preserves the brains of fœtuses of every

month. We have done more; we have dissected the brain before thousands of witnesses, before anatomists the most skilful in the investigation of the organ, such as Reil, Loder, &c. We have made this dissection, as well in our public as our private lectures; and I invite all those, who wish to know the truth, to witness this same demonstration; I will do it as many times as they deem it necessary. After that, they may determine if our engravings of the brain are not conformable to nature. Undoubtedly those, who have never seen the unfolding of the hemisphere, and the two orders of nervous fibrils, diverging and converging, cannot comprehend, and do not succeed in making those preparations. M. Spurzheim and I are no longer alone; there are already a large number of young anatomists, who are perfectly competent to defend our discoveries against all attacks, and this number is daily increasing, by the lectures which we are constantly delivering. If Messrs. Tiédemann and Carus had attended one of these lectures, they would have united their assent with that of M. Loder and Reil; and they and Messrs. Jourdan and Boisseau would be convinced, that, to form an anatomical monograph of the brain, they must rectify many of their opinions, as already we have shown many errors in the work of Chaussier.

Let us rectify another error of M. Boisseau. This savant represents me as asserting, that my anatomical and physiological opinions are so united, that the first cannot be destroyed, without, at the same time, demolishing the last.

I used the following expressions on this subject, in our reply to the report made by the committee of the French Institute, on our memoir, presented to this learned body the 14th of March, 1808,* p. 244, &c.

* *Researches on the nervous system, in general, and the brain, in particular*: — Memoir presented to the French Institute, followed by observations on the report, made to that body by its committee.

After having shown, that there are but few cases, where the structure of parts designate to the anatomist, the functions which depend on them, I say :

“ We must have recourse to other means. Usually the knowledge of functions precedes that of structure. It certainly is not necessary to understand the structure of the eye, or the organization of the optic nerve, in order to know that it is the organ of vision, &c. It is without anatomical dissection, that we ourselves have made most of our physiological discoveries; and these very discoveries might have existed for ages, without their correspondence with the structure of the brain being perceived. On the other hand, supposing that the knowledge of the organization had preceded that of the functions, it would have given rise sooner or later to conjectures, which infallibly would have been stamped with the prejudices of the age. Formerly, the seat of courage, love, sympathy, and cruelty, was placed in the heart; and after the same manner, the liver was assigned as the organ of anger and sensuality. If anatomy had been an unerring guide to the knowledge of the functions of the different parts, would Willis have caused the *vital spirits for motion to be secreted in the cerebellum*? Would Galen have attached the organ of smell to the anterior ventricles? Would the soul, alternately dislodged from the pineal gland, the corpus callosum, the annular protuberance, &c., have been placed by Sæmmerring in the vapor of the ventricles, and by Ackermann in the medullary substance, which lines the interior of these cavities, &c.? Would the memory have been placed in the grey substance, and the judgment in the medullary substance, of the hemispheres?

It might be expected, that anatomists, seeing the great diversity of the constituent parts of the brain, would have been the first to have deduced from it the diversity, and consequently the plurality, of the organs of the intellectual and moral faculties. But

when we observe that, even at this time,* Vicq-d' Azyr, after having made up the parts of the human brain, by ascending from insect to man, and afterwards analyzed it by passing from man down to the insect, has still admitted only a single organ of the soul, we are taught by experience, how very little the mere knowledge of a mechanical structure avails the physiologist. It is only by observing the phenomena of nature, regardless of the prejudices or vagaries of any metaphysical system whatsoever, that we can attain a correct knowledge of the structure of the brain, and of the nature of its functions. Herder, struck with the phenomena of the understanding in the various animals and in different individuals, conceived the idea of a plurality of intellectual organs, and even the hope of some day discovering them, by an attentive comparison of their brains with their peculiar qualities.

"A vast number of physiological and pathological facts should be collected, embracing many years, before any rational deduction can be made, as to the laws of the organization of the brain and the nervous system generally. But what could be the use of all these facts, if we had not previously supposed, that there was an intimate and necessary connexion with their material conditions? It is in this manner, prepared by physiological and pathological observations, that we have made, in a short time, discoveries, to which the scalpel would never have led us. And it is precisely the perfect accordance of intellectual phenomena with material conditions, which ensures a lasting duration of our anatomical and physiological doctrine of the brain.

"To say that the discovery of the functions of the brain is made independent of the knowledge of its structure, or that these functions have no immediate and necessary connexion with its structure, is a very

* And again that even now the metaphysical physiologists see in all these parts but one centralization of a single organ.

different thing. Can any one advance that motion and secretion have no relation to the organization of the muscles and viscera; and that digestion and the circulation of the blood have not an inseparable affinity with the stomach and the heart? &c.

"A doctrine of the functions of the brain, if it is in contradiction with its structure, must be necessarily false. If it be proved, that the brain is composed of glands, a secretory or excretory organ, it then is incapable of any superior function, and is to be classed with the other viscera. If it be a central point, where all the medullary fibrils which are found in all animals, can be demonstrated, notwithstanding their various and more or less numerous faculties; a cerebral mass always similar, then the plurality and diversity of the organs is overthrown. Whoever can show that the brain is only the origin or the central termination of all the nervous systems, will also have proved, that its functions are similar to those of other nerves. If a constant and invariable identity, in the constituent parts of their brains, can be proved to exist in different individuals of the same species, notwithstanding the gradual difference of their common faculties, then it would be impossible for us to assign their localities to organs, by comparing the predominance of their physical development with the predominance of their psychological energy. It is in this way, by placing the principal points of our psychological doctrine in direct opposition with the organization of the brain, they would destroy its foundations and annihilate it with all its conclusions. But, if it be true, that the constituent parts of the brain, from insect to man, are multiplied and vary in the same relation and proportion as the faculties; that all facts go to prove that the extraordinary energy of one faculty corresponds to an excitement or to an extreme development of some parts of the brain; that the derangement of a faculty is caused by the lesion or the disease of a cerebral part, in the same way that the pain or the

loss of a sense is connected with the lesion or the disease of its physical apparatus ; if, lastly, it is true that the brain is composed of a nervous system, different from all others, and divided into many other systems so distinctive, that the diversity of their origins, their bundles, their directions, their terminations, their points of union, may be demonstrated to the eye ; then it is a fact, that the anatomy of the brain has an intimate connexion, and is in perfect accordance with the doctrine of its functions."

These passages, the substance of which has been repeated in several places of this edition, should have taught M. Boisseau, that the physiology of the brain has never been predicated on its anatomy, and that I have never maintained as facts, that the gelatinous substance is the nutrient matter of the nerves, nor as to the diverging and converging fibrils of the hemispheres ; the principal points which Tiédmann and his followers pretend to have refuted, and the reality of which I shall soon show.

It is true, that we explain, by the duplicatures of the convolutions and their unfoldings, that the intellectual and moral faculties continue in hydrocephalous cases, which is denied by these gentlemen. As they have never witnessed this unfolding, and as apparently they can render no solution of this phenomenon, they have passed it by in affected silence.

M. Boisseau finishes his review of the preliminary discourse of M. Jourdan by a very lofty eulogium. "This discourse," says he, "presents a very happy application of the German philosophy, divested of its obscurities, to the physiology which is the boast of the French school."

If ever M. Jourdan succeeds in divesting Kantism and its excrescences of their obscurities, *magnus mihi erit Apollo*. When M. Boisseau quotes the pride of the French school, does he allude to the concentration of all the parts of the brain in one single organ ; to the large base of M. Lamarck ; to the masks

of monkeys, tigers, sheep, and owls, of Porta, Huart, and Jourdan? In short, I am of opinion with M. Boisseau that M. Jourdan, although very often inexact, is, however, a tolerable translator. He would do better to confine himself to his vocation, to furnish us translations, but not to write a preliminary discourse.

ANATOMY OF THE BRAIN, *containing a History of its Development in the Fœtus, with a comparative Exposition of its Structure in Animals*: by F. TIEDEMANN: Translated from the German by A. J. L. Jourdan; with 14 plates. Paris, 1823.

I have in another place commended the works of Messrs. Carus and Tiédemann. If M. Carus had not encumbered his positive knowledge with the bombastic transcendental philosophy; if his inflated style, his accumulated particples, and gigantic phrases had not at every moment put the attention of his reader to torture, he might have been regarded as the origin of the work of M. Tiédemann, which is much better written. I have a high opinion of the merit of these two authors: I much prefer the nature of their researches to the barbarous and fruitless mutilations of our young physiologists. But, certain authors, who are not more capable of determining the errors than the truths of the anatomy of the brain, pretend to discover, in the researches of M. Tiédemann on the brain of the fœtus, not only a refutation of our anatomical discoveries, but also of all the doctrine of the functions of the brain and its different parts. It is apparently under this pretence, that they oppose to me my two estimable countrymen, and compel me to my defence. I accept the challenge, when the interests of truth are at stake.

Advantage of Comparative Anatomy.

M. Tiédemann justly insists on the great advantages to be derived from comparative anatomy, in order to understand the structure of the brain. "Comparative anatomy," he remarks, "explains to us the origin and successive formation of the nervous system and the brain, from the most simple to the most complex of animals, and to man. There is no apparatus of organs, in the formation of which so perfect a gradation, from the simple to the complex, is found, as in the cerebral and nervous system, which is established on a uniform plan in the whole series of animals. It is by studying the gradual composition of the structure of the brain in animals, that we attain a distinct idea of an organization, so complicated as this viscus in man, and thus we finally can comprehend the arrangement and connexion of its parts.

This is precisely one of the principles I adopted, in the study and exposition of the anatomy of the human brain, and which, since the publication of this work, has served as the basis of so many other anatomical treatises, and among others of those of Messrs. Carus and Tiédemann, &c. But M. Tiédemann accuses me of having only described and figured, in relation to the nervous system of animals, the nerves of the caterpillar, and the brain and the spinal marrow of the hen and some of the mammalia; and he thinks, that no axiom relative to any point of anatomy or physiology has any foundation, when it is not ingeniously deduced from *all* the facts and observations, having any relation to the object in question. M. Jourdan makes M. Tiédemann say, *of all the facts*, which would for ever preclude a knowledge of the anatomy of the brain. M. Tiédemann speaks only of a very great number of facts as necessary (*ans der Fülle der Thatsachen*), which is much more reasonable. At the time when M. Tiédemann published his work, he could have

known the contents of my first volume only, which contains the anatomy of the brain. But if he had read it attentively, he would have found that, in many places of the text, the comparative anatomy of many animals is alluded to, without designating all these particularities. My design was not to publish a complete comparative anatomy: I only wished to make use of as much as was necessary to establish certain and immutable principles, as to the laws of the organization of the nervous system, in general, and the brain, in particular. This I accomplished; for, all that I have seen since in the brains of different animals, and all the recent works of other authors, on the same subject, have not overthrown one of these principles. As M. Tiédemann is no less persuaded than myself of the uniformity of the plan of nature in the formation of brains, why are such an infinity of facts necessary for him to make deductions of general laws? What would be the exact number required, for an anatomist to establish an axiom or a principle?

After these reflections, I hold it of much greater importance for me to apply the comparative anatomy of the brain to its physiology, than to the simple descriptive anatomy. There are found, therefore, at the exposition of each organ, numerous observations on the difference of the human brain, when compared with the brains of various species of animals, and with each other. For a long time I have been convinced of the same thing, that M. Tiédemann has just remarked, that "we need a comparative psychology, in order to understand the uses of the constituent parts of the brain; that it is required also, that the phenomena of the cerebral action should be carefully observed, from the lowest rank of animals to man, and that afterwards they should be compared with the structure of the organ itself. This comparison of the actions with the organization of the brain, in the various animals, will unfold to us the functions of each of its parts." As M. Tiédemann adds that, even now we are defi-

cient in such knowledge, it may be the case, that he may have wholly forgotten the lectures that I gave at Heidelberg, and in nearly all the universities of Germany, and that he has not read any of the multiplied extracts, which have been made by MM. Froriep, Walter, Blæde, Ackermann, Muller, &c. &c., nor even the whole of the first volume of my large work.

Undoubtedly this method would be efficacious, if it were practicable; but we must first have an exact idea of the mechanical aptitudes, instincts, propensities, and talents in general, and of the moral qualities and intellectual faculties of animals and man. The connexion between the actions and the structure of the brain, which is not founded on the physiology of that organ, will be of no advantage to any philosophy. This method would be absurd in any system, which admitted only a single faculty, infinitely modified; which gave to all the cerebral parts the same function; where it is even overlooked, that in the different species of animals, the masses of the brain equal in weight and volume, should necessarily have a peculiar structure, and, consequently, functions totally different. All comparative anatomy and physiology is at fault in the supposition, that the weight and volume of brains are the standard of the number and energy of their functions; or, in other words, that the functions are as much more in perfection, as the mere voluminous cerebral masses constitute a more concentrated centralization.

Is the whole Nervous System formed at the same Time?

M. Tiédemann says; "The history of the formation and development of the encephalon in the fœtus is another part of anatomy and physiology, which has been equally neglected until very lately. The sagacity

of Harvey had led him to the discovery of a law, the correctness of which the Germans have recently proved, and, according to which, the fœtus, as well of man as of animals, is not at first provided with all its parts, which would be only less developed ; but that it commences by having a simpler form, and passes through several successive degrees of formation, before it attains its greatest perfection. Would not a similar progress take place, I thought, in the structure of the brain of the fœtus? and cannot we infer from thence the successive formation and structure of this organ, which, in its perfect state, presents so complicated an organization?"

In the report on our memoir by the Committee of the Institute of France, they say, *In the nervous system, all is formed simultaneously.* At that time I refuted this proposition at some considerable length.* The following is another similar to it.

"Is it then certain, that in the living organism all the parts are formed at the same time, so that we can speak of a development and increase, but not of an origin, formation, and successive perfection and completion?"

"We cannot engage ourselves with the hypotheses of the theory of *preëxisting germs*, of their development or evolution, nor of generation or production so often renewed. In admitting laws, according to which an organizing tendency (*nisus formativus*) is inherent in all beings, and after which all the parts tend to form a whole, we have no occasion to have recourse to germs, generally diffusive. The crystals of salts, stones, metals, are they entirely formed simultaneously, or do they form gradually? The bud, the flower, the pollen, the fructification, the fruit, the seeds of trees, are these all formed at the same period? or, do each of these parts successively arise? If the

* *Researches on the nervous system*, with observations, &c. pp. 149, 150. 1808.

lime tree and the oak extend their branches from every part; if the aquatic lizard reproduces his tail, his feet, and eyes; if the snail, his head, and the crab, his claws; who shall persuade us that, in these cases, the germs were confined and awaited their deliverance? How does it happen that, as the more or less nourishment is given to these germs, we can modify them and make them produce spontaneously leaves, branches, flowers, and fruits? How do the stamens transform themselves into petals, the pistils and capsules into stalks, and the calix, into leaves? How does the larva of the working bee become, solely by the influence of surrounding circumstances, a queen bee? The same substance, which serves as nutriment to the plant, fish, bird, dog, and man, is changed into the constituent parts of all these beings, and is transformed into seed, by which each propogates its kind; are the complete germs of all these beings and their constituent parts, contained in this alimentary substance? The incubated egg has its different periods of formation. It is natural to suppose, that the formation of the vessels precedes that of the other parts. The head and trunk are visible a long time in the fœtus, before the extremities begin to develope themselves; the intestinal canal acquires by degrees its length and development; if the osseous substance is engendered and secreted at so late a period, if the teeth, at an age so advanced, what is there to prevent the successive generation and origin of other parts? In a human fœtus of about six months, the nerves of the vertebral column, the muscles of the eye and the tri-facial nerves are sooner formed than the olfactory nerve, and the latter before the auditory, the optic, the pyramids, and the annular protuberance, in which scarcely any traces of nervous filaments are perceptible. The peduncles of the brain, on the surface of which the bundles of fibres are so distinct afterwards, at this time appear to consist only of a mass of gray substance; the optic thalami, corpora striata,

and the hemispheres do not contain any distinct filament, (without preparation and to the naked eye); they are discovered sooner in the posterior and middle, than in the anterior lobes, &c."*

Thus, as regards the successive formation of the various cerebral parts, I perfectly coincided with Carus and Tiédemann, in 1808 and 1810, and their excellent writings gave me much more gratification, as I was already familiarized with this ingenious and fruitful idea. But, without intending to undervalue the advantages to be derived from the examination of the foetal brain in its different ages, I have always inclined to the opinion, that the study of the brain of the various classes of animals below man, is a surer method of attaining a knowledge of the general laws of the organization of the nervous system and brain. No other means would be necessary, if the opinion of Carus, Tiédemann, and several German anatomists be true, that the successive formation and development of the human brain, passes through all the degrees of formation and development of the brains of animals, always becoming less and less complicated. But some inferior animals have several cerebral parts, which are not found at any period in the brain of man. M. Carus himself has advised anatomists not to give too much weight to this supposition, so specious in theory, and so frequently false in reality.† A practical discernment is required, to obviate premature conclusions, and it is indispensable to rectify in the superior classes that, which may appear to be apparent in the inferior. I would wish, then, that the successive development of the brain should be studied mostly in the foetus; but, to know the true structure of this organ, the continuity and connexion of its parts, the direction and the varied interlacings of its fibrils, their origins, rein-

* *Anatomy and Physiology of the brain, &c.*, Vol. 1. p. 240. 1810.

† Versuch einer Darstellung des Nerven Systems und insbesondere des Gehirns, p. 262.

forcements, and expansions, &c., I should always prefer either the adult human brain, or brains less complex, but more or less analogous to it.

This preference is fully justified by the success which I have obtained, in comparison with that of Carus and Tiédemann. To judge of it from the great number of inaccuracies and erroneous results, disseminated in their works, it appears to me doubtful, if they could have discovered with any accuracy from the inspection of fœtal brains, had they not previously known my anatomy of the brain, and the principles on which it is founded. Would they not, like all their predecessors and the brothers Wenzel, have described minutely and without any order, the forms and their modifications, each little hollow, each furrow, &c. &c., instead of tracing out the continuity of the fibres, the mutual connexion of parts, their use in the vegetative life, &c. &c.?

In order to prove, that the examination of the fœtal brain is far from being sufficient to an understanding of the structure of the parts, I will give a few examples. M. Tiédemann, when speaking of the medulla oblongata, only describes three nervous bundles on its anterior surface; the pyramids, the corpora olivaria, and the bundles or peduncles of the cerebellum. If he had compared the medulla oblongata of the fœtus, with that of the sheep or the ox, &c., he would have perceived, that, on each half of the same surface there are six very distinct and visible bundles; therefore, the brain of the fœtus does not in all respects exemplify the gradual composition of the human brain. The same bundles also exist in man, but they are concealed by others, which are larger in man than in most animals.

The inspection also of the human fœtal brain has not revealed to him the large transverse band below the annular protuberance, surmounted by the pyramids, which is very distinct in nearly all the mammalia, and is covered in man by the inferior third of the large annular protuberance.

M. Tiédemann assumes that the corpora olivaria constitute a bundle, which goes to form the tubercula quadrigemina, at the same time that the tubercula are in connexion with a particular bundle, situated between the corpora olivaria and the peduncles of the cerebellum. M. Tiédemann, with his critical acumen, should have been aware of his error. He has seen that the tubercula quadrigemina form already a large mass, before even the corpora olivaria exist. He might have seen that the corpora olivaria, either do not exist at all in most animals, or are scarcely visible; yet still their tubercula quadrigemina are larger than in man; as for instance, in the horse, ox, &c. With more attention, he might have seen, that the corpora olivaria are not a bundle, but a ganglion, which is seen at a later period than the bundle of the tubercles, and which produces a particular bundle which goes into the two great cerebral ganglions, the optic thalami and corpora striata. An inspector of the brain of the mole, and a perusal of our anatomy of the brain, where we have treated of the corpora olivaria, would have convinced him of it.

According to M. Tiédemann, the two anterior pillars of the fornix, produce two very thin lamellæ, which go to the inferior surface of the corpus callosum, and give origin to the septum lucidum. This is an incorrect view of it. At the anterior termination of the innermost convolution of both middle lobes, there arises a fibrous bundle, mingled with a grey substance of only a line in breadth, and which often forms a kind of band, at the anterior internal part of the great fissure between the anterior and middle lobes. This bundle goes towards the median line, proceeds onwards above the reunion of the optic nerves, immediately before the anterior commissure, is ramified and expanded on the interior border of the hemispheres into a thin membrane, and, united with that of the opposite side, forms the septum. The filaments of this nervous membrane pursue a diverg-

ing direction from below upwards, and terminate by intermediate fibres in the median line of the great commissure,* which, divided perpendicularly in its median line, exhibits in its whole thickness the same radiated expansion, as described, p. xi.

The transverse bands or interlacings, and the interlacing in the median line of the annular protuberance of the great commissure, are wholly unknown to him. See my large work, Vol. i. p. 314, in 4to.

M. Tiédemann, always vague in his principles, takes, in pages 107 and 165, the vermiform eminences for the commissures. With what foundation? At another time, the annular protuberance is, in his opinion, the commissure of the cerebellum. When the vermiform process is single, as in birds, &c., how can it then be at the same time both cerebellum and commissure?

I cannot tell how MM. Carus and Tiédemann have conceived, that I regard the posterior parts of these tubercles, as being the roots of the olfactory nerve. "As the nervous bundles, I remark on the same page, take the same direction as those of the optic nerve, it might be supposed, that it is prolonged in the nervous layer, to which the olfactory nerve is united at the point of its separation. But this opinion seems to be contradictory to comparative anatomy, at least, in the present state of our knowledge. These tubercula quadrigemina are found in the dolphin and porpoise, in whom no olfactory nerve can be detected." Since that time, I have been convinced, that the posterior pair is a ganglion of reinforcement or of increase for the visual nerve, like the anterior. The manner, in which these two pairs contribute to vision, must be different, as, in the various species of animals, they are in different proportions; and as, even in other species, the posterior pair is either scarcely visible, or wholly

* M. Tiédemann has quoted only the four last lines of this passage, taken from my large work, Vol. i. p. 313, in 4to.

wanting, although vision may be perfect, as for example in birds.

Page 176. M. Tiédemann commends the opinion of Reil, that the number of the branches of the cerebellum and their divisions, or subdivisions, increase in the ratio of the progress of the animal organization towards perfection. He adds, that, from these facts the observations of Malacarne may be plausible, by which he attempted to establish an intimate relation between the number of the laminæ of the cerebellum, and the extent of the intellectual faculties of the human race. That physician found them much less numerous in idiots, than in persons distinguished by force and brilliancy of mind. Ideas of perfection are relative. The cerebrum and cerebellum of the elephant and dolphin are more complicated, and are composed of more convolutions than the same parts in man. In the eye of nature, perhaps, they are more perfect than in man, and it should be so, if Reil and Malacarne are correct. I wish to know, how often Malacarne has repeated his observations, in what manner he has counted the laminæ of the cerebellum, and whether, at the same time, he has observed the cerebrum. The cerebrum is defective in most idiots, and often the cerebellum equally so; but I have seen many idiots, as regards their intellectual faculties, whose cerebellum had acquired an enormous development, and who were addicted to the most brutal salacity. Why, then, this ready credulity to the assertions of some, on the authority of a single erroneous observation, while experiments, a thousand times repeated and confirmed throughout the whole animal kingdom, are disregarded? Moreover, imbecility is not the result of a defective organization solely; the functions of the cerebrum may be impeded by other indispositions; for, frequently, we see idiocy with an apparently perfect organization from birth.

M. Tiédemann remarks, page 223, "that when a fresh brain is examined, of a subject of seven months,

that a difference is not so perceptible between the white and grey substance of the corpora striata, as in the encephalon of an adult, and that these bodies are formed of an uniform and reddish mass, in which many vessels are ramified. The name, therefore, of corpora striata, is not applicable to them in the foetus."

In this instance, again, the corpora striata are not exceptions to all the other parts of the cerebrum. M. Tiédemann is well aware, that, during the period of formation, the pulpy, non-fibrous substance is more abundant than at a later period; and that, in general, the white fibrous substance cannot be visible before it is formed by the grey substance, and the great number of blood-vessels which primarily form this last. The name of corpora striata was never appropriate to these great ganglions. There were never white striated lines alternating with grey. The nervous bundles are composed of a very large mass of pulpy, non-fibrous substance, of the size of a small pullet's egg, by the union of an infinity of minute filaments which there arise, and these bundles cross this large mass, which is in fact the great superior ganglion of the cerebellum, in a diverging manner, like a fan. M. Tiédemann is only aware of the existence of a smaller portion of this ganglion, which is seen in the ventricles and called the corpora striata. He is ignorant of its larger external portion, which is directly connected with the internal, and which is enveloped in an isolated place, covered with minute convolutions, concealed by the middle lobes. Consequently, we can only discover, after having scraped the pulpy substance either in the ventricles or in the opposite side, the striated, white nervous bundles, more or less large, as the convolutions, which they form by their expansion, are more or less considerable. Usually the bundles, which take a direction towards the posterior lobes, are stronger in animals, than those which go to the smaller anterior lobes.

Page 247. M. Tiédemann says, that the brain of monkeys is larger and more arched than the brain of the marten, fox, cat, dog, hog, sheep, goat, ox, horse, hind, and the stag; that the convolutions and anfractuosités, are more numerous, than in the animals just enumerated. The brains of the largest monkeys are very similar to those of dogs. None equal in size the brain of the horse, not even that of the ox or stag. The orang-outang's is like a new-born infant's,* that of the chimpanse is smaller, fig. 1; their convolutions and anfractuosités are not near as numerous as in the hog or ox. When, with Baron Cuvier, it is said, that, excepting the chimpanse and the gibbon, we do not find convolutions on the posterior lobe, we have only to refer to the brain of the orang-outang and the guenon, Pl. LXXVII. fig. 1, to disprove the assertion. And when M. Tiédemann repeats, in page 248, that the brain of the adult man is distinguished from that of all animals, by the volume and height of the hemispheres, and by the greater number of the anfractuosités and convolutions, I refer him to the brains of the porpoise and elephant, Pl. xxxv.

Page 294. M. Tiédemann adopts the opinion of several anatomists, viz: that all animals, including even the mammalia, with the exception of the quadrumana, are destitute of the posterior lobes of the cerebrum. I have rectified this error in another place. As, by this supposition man and the quadrumana alone possess the posterior lobes, what would be the faculty or propensity that the latter have in common with man only? This is another happy effect of the mechanical inspection of the brain, instead of attending to physiological principles.

I have already repeatedly rectified the translation of M. Jourdan. The following extract shows his intention. M. Tiédemann, page 212, compares one of my opinions with that of Reil. "M. Gall," he

* Atlas of the large work, Pl. xxxiv. fig. 2.

remarks, "rightly deriving the optic nerves from the tubercula quadrigemina, considers the optic thalami as the organs of reinforcement of the peduncles of the cerebrum, and gives to them the name of great cerebral ganglions, to distinguish them from the corpora striata, which he calls the little ganglions. According to him, their use is to increase the volume of the pyramidal bundles, which traverse them, by furnishing them with cortical substance and new medullary fibres. Reil affirmed, that they formed a sort of protuberance, placed on the internal side of the cerebral peduncle, and that they serve to concentrate its fibres into a single focus or centre, whence they diverge afterwards into a great circle formed by their expansion in the whole cerebrum. According to his view, they were organs, which went to form but the fibres of these cords, which, taking a direction from behind forwards, become radiated in the posterior lobes, that is to say, he assigns for their use, the forming of the retrograde radiation, that they are the centre of the organization of the cerebral peduncles, the focus of radiation in every direction.

"None can refuse their assent," continues M. Tiédemann, "to these ideas (M. Jourdan translates, *to the ideas of Reil*), when it is recollected, that the cerebral peduncles really acquire an increase of size, in crossing the optic thalami, on leaving which, they disseminate in the hemispheres of the cerebrum many more fibres than they were composed of, when they entered them. The increase of these two cords is effected by the numerous sanguineous vessels, which cover the optic thalami, and is the result of a great separation of the cerebral substance, (*non-fibrous*,) whence new medullary fibres arise. The multiplicity of the sanguineous vessels, in the optic thalami is proved by the abundance of the cortical substance, which is formed there, and which has a texture much more vascular than the medullary substance, as all anatomists allow: this great influx of blood is evidently to permit a

greater increase of the eminences, and to communicate to them more activity, by a more abundant supply of nutritive matter."

It must be evident to those, who have read the beginning of this passage, and who are acquainted with my principles respecting the laws of the organization of the brain, that M. Tiédemann has fully adopted my views, as he must do, as a rigid observer and acute anatomist. Why does M. Jourdan insinuate, and even distinctly affirm, that M. Tiédemann has adopted the opinion of M. Reil? In fact, the ideas of Reil, so sagacious in other respects, are no way admissible. The concentration of the fibres of the peduncles into a single point, does not increase the volume; it does not aid in their expansion, which is better effected by the transverse bands, the consideration of which remains still neglected.

M. Jourdan further mutilates the text of M. Tiédemann, when he represents him as saying, that I give the name of *great cerebral ganglions* to the optic thalami, to distinguish them from the corpora striata which I call the *little ganglions*. M. Tiédemann says, in conformity to my work: "According to M. Gall, the optic thalami are ganglions to the cerebral mass, and he calls them the great *inferior* cerebral ganglions, to distinguish them from the corpora striata (the great superior cerebral ganglions)." * The same intention is shown, p. 229, where M. Jourdan translates Reil and Gall, instead of which M. Tiédemann says, Gall and Reil. The first, (who is myself, according to Tiédemann, and who, quoting from Jourdan, is Reil,) gives to the corpora striata the name of great superior cerebral ganglions, and the other calls them, great external cerebral ganglions, as Reil has shown us in his demonstrations at Halle. Such gross mistakes of a translator induce the belief, either that he

* Tiédemann, l. c., p. 130. Anatomie and Bildungs-geschichte des Gehirns im fœtus des Menschen.

is a stranger to his subject, or that he designedly errs.

It is not my intention to rectify all the errors of the work of M. Tiédemann, in other respects a very important one, nor all the faults of the translation of M. Jourdan. It will be sufficient to maintain the three principal points, in regard to which M. Tiédemann and myself are at issue. The first, that the white fibrous substance does not arise from the pulpy non-fibrous substance: the second, that there are not two different nervous systems, one converging, the other, diverging: the third, that the unfolding of the convolutions of the hemispheres does not take place.

Is the Doctrine tenable, that the white Fibrous Substance of the Nervous System arises from the Pulpy Gelatinous and Non-Fibrous Substance?

Let us begin with the medulla spinalis. M. Tiédemann says, p. 128: "It is easily ascertained at an early period, in the second, third, and even in the fourth months, that the canal of the medulla spinalis has, in proportion to the thickness of the coats of the medulla, much greater size than afterwards. The contraction which takes place, by the increased development of the embryo, is caused by the deposition of a new substance, formed by the pia mater, the materials of which are derived from the blood sent from the heart, and which, increasing the size of the coats of the cylinder, must necessarily diminish the calibre of the central canal. This substance is soft, reddish, and filled with numerous minute vessels, in the course of the two last months. It cannot be doubted, from the above, that the cortical substance of the medulla spinalis has an origin posterior to that of the fibrous medullary substance, and that it is placed from within outwards, on the surface of the latter. Therefore, Gall's opinion is erroneous as respects the medulla

spinalis, who pretends, that this same cortical substance is formed anterior to, and is the matrix of, the the medullary; for, the roots of the spinal nerves are already perceptible in the second and third months, although, at this period, the cortical substance has not been deposited in the canal of the medulla spinalis."

This is the conclusion adopted by M. Tiédemann, in accordance with several German anatomists. Before I offer proofs in support of my proposition, let us quote again from M. Tiédemann, and it will be found that his own observations are in opposition to his notions.

"During the first month, and at the commencement of the second, he observes, p. 125, the medullary spinalis has the form of a membranous canal, which *contains a liquid and transparent fluid*. Towards the end of the second month, this fluid is converted into a *soft and pulraceous mass*, like the white of the egg. As the tissue of the medulla acquires consistence, its transparency diminishes. If the fœtus is put in alcohol, the soft and fluid substance of the medulla spinalis coagulates and becomes firmer. At the end of the second month, and at the commencement of the third, *fibres cannot as yet be seen, even by the aid of alcohol; and, on examination of the medulla with the microscope, it appears to be composed of minute globules*. The small globules, which are disposed parallel to each other, and take a longitudinal direction, cannot be seen before the beginning of the fourth month on the anterior surface. These fibres gradually increase in number, not only anteriorly, but also on the sides of the two principal cords of the medulla spinalis. During the whole of the first month, and at the commencement of the second, the medulla spinalis has the form of a membranous canal containing a limpid and transparent fluid. The coats of this canal, which enclose this fluid, are not composed of medullary substance, but are formed by the dura mater, which, at this period, is thin and with-

out any appearance of fibres, and by the pia-mater abounding with blood vessels.”

I ask M. Tiédemann how he can infer from these data, that the pulpy, non-fibrous substance, is posterior to the white fibrous substance? If he would examine without prejudice, he would find, as he states most distinctly, that the pia-mater with its numerous vessels, and a liquid substance, successively glairy, pulpy, gelatinous, and reddish, exists a long time, before any trace of fibrous matter is perceptible. Truly, a light breaks upon us, when, after reading the premises, we arrive at the unexpected conclusion, that the cortical substance of the medulla spinalis has an origin, posterior to that of the medullary fibrous substance! Or does M. Tiédemann wish to take advantage of the expression *cortical*, as if I had maintained, that it is a substance, placed on the external surface of the medulla spinalis, which gives origin to the other? But, is he not aware, that we have always very distinctly stated, that it is the pulpy, gelatinous substance, the non-fibrous, abounding in blood vessels, the first secreted by the pia-mater, which is the source of the nervous filaments, which nourishes and multiplies them, and which consequently may justly be called the *matrix*, the nourishing substance of the nervous filaments? Whether placed externally or internally, it is always the apparatus of origin and reinforcement; its function is at all times the same.

Let us follow M. Tiédemann, and it will be seen, that his prejudices always lead him to some false conclusion.

“The anatomy of the foetus is no way favorable to the hypothesis of M. Gall, according to which the medulla spinalis of man and the superior animals would be composed of ganglions or enlargements of the grey substance, distinct, but adherent to each other, and as many in number as the pairs of nerves which it furnishes. If the ganglions were a part of this medulla, which is first formed, and if the medulla

itself resulted from their union, it would be the case, that, in the embryo they would be distinctly visible, as in it the medulla spinalis is found in the lowest state of organization. But, on examining it from its first period, nothing can be discovered like enlargements or ganglions." p. 134.

It is because, from the commencement, the medulla spinalis is found but little developed, and because the period for the appearance of the nerves has not yet arrived, that these enlargements cannot be distinctly perceived. How can they be seen in a medulla, which as yet has no consistence, which cannot as yet be separated from its sheath? Have not anatomists, and even the committee of the Institute themselves, denied the existence of these enlargements, so distinct and so evident, the medulla spinalis of man, of the ox? But let us proceed:

"But Gall is right in saying," remarks M. Tiédemann, "that in the adult, the parts of the medulla, the most amply supplied with cortical substance, are those whence the largest nerves take their origin."

Well! if the largest nerves must have a more abundant supply of a cortical substance, does it therefore follow that the lesser need have none? Does not that prove, that the non-fibrous substance will be so much the less perceptible, as the nerves to which it gives origin are the more delicate; but that without it there can be no fibrous substance?

"It may be seen at an early period," continues M. Tiédemann, "that the medulla spinalis of the fœtus is larger in those points, whence the great rachidian trunks arise, which form the nerves of the upper and lower extremities: its canal also is more dilated in the same place, during the last months, when the coats of the medulla are strengthened by the formation of new medullary fibres, and when the canal is diminished, and then filled up gradually by the cortical substance there deposited, it is in these places that most of this grey substance is found abounding in numerous blood

vessels, which give it a reddish appearance. But it is also true, that this considerable mass of cortical substance belongs to a secondary formation, and is no part of the original state."

Certainly these considerable masses of non-fibrous matter belong to a secondary formation, since the nervous filaments, which they produce at a later period, do not exist at first. It is thus, also, that many other ganglions, with their nervous system, are secreted afterwards, as the olivary ganglions, the corpora geniculata, the pineal ganglion, &c. &c., and their nervous bundles; it is thus, also, that all the ganglions increase in gelatinous matter, in proportion as they have their nervous productions to reinforce, as the corpus ciliare, or the central point of the grey matter in the interior of the hemispheres of the cerebellum. But the addition of the fibrous substance is always preceded by an increase of the non-fibrous. This is strictly conformable to the laws of the vegetation of plants. Pull up a tree in November, December, or January, and you will find that, while the vegetation of the branches was wholly suspended, the growth of the roots was vigorous. You will find a large number of white thick filaments, which are distended by the mucilaginous matter: subsequently, these large filaments are changed into others much more delicate. It is the same with the buds; before they are extended into branches, they are enlarged by the accumulation of the mucilaginous matter of the *cambium*.

"The presence of a great quantity of grey substance in these places of the medulla spinalis, where the large nervous trunks come out, which is so filled with vessels that Ruysch believed it wholly vascular, contributes entirely, during life, to increase and exalt the nervous action according to the general law, that the force and energy of an organ is in proportion to the degree of arterial blood, distributed to it. M. Gall is in error, in affirming that the grey substance, to which

he gives the name of matrix of the nerves, is the first formed, and is that, which produces and nourishes the nerves. But I agree with him, that it strengthens and fortifies the action of the parts of the brain and nerves, which arise from it, but only as this effect is produced by the arterial blood which circulates in it, and by the greater rapidity with which it repairs the loss, induced by the exercise of the vital action. I admit then an intimate relation between the size of the spinal nerves, and the enlargements which are seen in those places, where these nerves originate. This is easily proved in fishes, where the origins of the nerves always produce particular ganglions, [it would be better to say, where particular ganglions give origin to the nerves,] whenever these nerves, and the organ to which they are distributed, are greatly developed, or when there are particular organs, which are wanting in other fishes."

After the foregoing, M. Tiédemann enumerates several species of fishes, where the nerves always originate from the ganglionic substance, and infers from it, that no one can doubt, that the local increase of the mass of the medulla spinalis, by the addition of more or less of this substance, is for the purpose of exalting the action or activity of the nerves, which arise from these ganglions, and which would be superfluous, if the sanguineous vessels could effect the same result by their great number only.

I have delineated in my large work the nervous system of voluntary motion of the caterpillar, where all the ganglions form a kind of chaplet, which shows these enlargements so distinct and connected by a double nervous cord, that their existence is evident at every point, where the nerves originate. In serpents and in all animals, whose medulla is prolonged, these distances are very clearly marked. It is the same in birds, as is seen in the medulla spinalis of the hen, which is also engraved in my work. Examine it in the marten and the hare, even after these animals have

been cooked, and you will readily perceive throughout its whole length, the enlargement very distinct at each origin of a nerve, without taking into view those longer ones, whence proceed the nerves of the extremities. The same occurs in all animals and in man, but not in so evident a manner, since the distance from one enlargement to another, is less. To be convinced of this, draw out the medulla from its membranes, keep it in water, and not stretch it upon a board, as we have seen it done. The enlargements are always found at the union of two vertebræ, as the parts where they are in contact, are wider than the canal of the bodies of the vertebræ. As to the increase of the vital power by ganglions, I admit it, but only inasmuch as a larger nerve, *cæteris paribus*, exercises a more energetic action than a smaller one, and because all excitement stimulates the action of an organ. Reil thinks that the ganglions have the functions of modifying impressions made upon nerves. It is in this way mankind reason and rave, when they attempt to explain those matters, which are beyond our capacity.

Let it be borne in mind, that it is not the fibrous, but the gelatinous, non-fibrous substance, that is penetrated by an abundant tissue of blood vessels; that the whole formation of every organ is necessarily effected by the vascular system: is it not then conformable to physiological principles, to seek the primary origin of the nervous filaments in a substance directly secreted and thoroughly penetrated by an infinity of blood vessels? When one is forced to assert, that, wherever ganglions exist, filaments come from them; that, wherever a nerve is united to a ganglion, it goes from it increased in energy; that all the nerves are more or less accompanied by this same substance, and by it that they acquire a successive increase so as to become conical: it is difficult to understand, how one can fail to distinguish in the non-fibrous substance, the primary and sole origin of the

nervous filaments. Let the evidence in this matter be properly weighed, and the position would no longer be maintained, that, in the second month, no nerve can be distinguished, coming either from the medulla or the brain: that, even in a fœtus of seven or eight months, no fibrous structure can be seen in the two cords of the medulla spinalis, not even by a powerful magnifying glass, nor when hardened in alcohol: and, that the roots of the spinal nerves may be perceived in the second and third months, which may be very possible, although M. Tiédemann could demonstrate only that the fluid substance, which had become successively gelatinous and deposited in the canal of the medulla spinalis, is not the same substance, which I describe, as generating and nourishing the nerves; and after having denied in many places the existence of enlargements throughout the length of the medulla spinalis, one would not be compelled by the force of facts to avow, that the soft and reddish substance, into which enter numerous vascular ramifications, is, at the ninth month, more abundant *on all the points where the nerves arise from the lateral part of the medulla*, and still more abundant at the origin of the large nerves of the extremities.

In addition to all these proofs, it may be remarked, that, in the most inferior animals, the nervous ring, which surrounds the œsophagus, is provided with a mass of non-fibrous substance, which gives origin to the fibrous matter, which terminates by forming the ring and the extreme ramifications or rays: that the medulla oblongata is but the continuation of the spinal nervous cords, increased by as many ganglions as there are pairs of nerves going out, and that these same ganglions, which form a single large expansion in the superior animals, exist more or less numerous, and more or less separate and distinct, &c., in the inferior.

Hitherto I have demonstrated, that in the whole length of the medulla spinalis the nervous fibrils, whether the cords themselves or the nerves, originate

from a mass of non-fibrous cerebral substance, and that the opposition of M. Tiédemann and his partisans is so much the more gratuitous, as they themselves teach, that, in the first month, there is no sensible difference between the two fibrous and non-fibrous substances of the medulla spinalis, and that, consequently, nothing can be affirmed as to the non-existence of the non-fibrous substance. We shall refute M. Tiédemann by his own words, as to the cerebellum and cerebrum.

Page 119, he says: "I have repeatedly dissected fresh brains, either of fœtuses of six, seven, eight, and nine months, or of new-born infants, in order to acquire a just idea of the relation, which might exist between the different cerebral substances in the different portions of the encephalic organ. The uniform result has been, *that it is impossible to establish* any distinction between the cortical and the medullary substance, in the brain of the fœtus. All the constituent parts are formed of an homogeneous and white reddish substance. This redness is evidently owing to the great number of minute blood vessels which are distributed to the cerebral substance. In all parts, where we have found the grey matter in considerable masses in the adult, as in the cerebral peduncles, where it takes the name of corpus nigrum, corpora striata, optic thalami, &c., I have discovered that the vessels were larger and more abundant, than in those, which are composed of medullary substance after the period of birth. Therefore, the names given by anatomists to certain parts of the brain, are not appropriate, when they are examined in the fœtus; for example, the terms corpora striata or canniculata. In fact, the parts, which correspond to these eminences in the cerebrum of the fœtus, are not striated, but composed of an homogeneous white mass, with a reddish tinge, and penetrated by a multitude of vessels of large size. There is, moreover, no difference as regards color, between the cortical and medullary

substance, either in the convolutions of the cerebrum or in the layers of the cerebellum. The exterior layer, which corresponds to the cortical substance, is of a reddish white, like the interior layer corresponding to the medullary. The only sensible difference, which appears between these two substances in the fœtus, which are so easily distinguished from each other in the adult, is, that the exterior layer like the bark in its nature is softer, and perhaps somewhat more abundant in vessels than the interior portion."

By this extract it appears, that the non-fibrous substance much exceeds the white fibrous substance, during the period when the brain is not wholly formed; it is therefore necessarily the primary, and it is from this that fibrous substance takes its rise. M. Tiédemann often asserts with emphasis, that always the fibrous substance is increased by the non-fibrous. As we were the first to demonstrate this fact, how could he so far have committed himself as to assert, that the white fibrous matter is anterior to the reddish, grey or non-fibrous? In the corpora ciliaria of the hemispheres of the cerebellum, in the first great ganglions of the brain, or the annular protuberance, in the crura cerebri, in the optic thalami, in the corpora striata, &c., the white fibrous substance increases in proportion as the non-fibrous accumulates in these parts. Many masses of gelatinous non-fibrous substance evidently exist before the nervous fibrils, which afterwards originate from them, as the corpora genicula, the bulbs of the olfactory nerves, &c. Does not all this show in a decisive manner, that, at every period and throughout, the gelatinous substance fills the interior or the exterior surface of the hemispheres, gives rise to the nervous fibrils, or, in other words, that it is the matrix, the nourishing substance of the white fibrous matter of the whole nervous system?

Add to this, all that we have said in my large work, vol. i. p. 37 and 47, when treating of the nervous system of the vertebral column, and every doubt of

the use of the non-fibrous substance will be entirely dissipated.

Is it true that, both in the Cerebellum and Cerebrum, there is a Diverging and a Converging System?

All modern anatomists are of opinion, that the corpora restiformia, or the peduncles of the cerebellum, enter into the hemispheres of the cerebellum, that they there meet a new ganglion, the corpus ciliare, where their nervous mass is reinforced, and whence it spreads into branches and minute ramifications. It is at present admitted, that the pyramids are reinforced in their passage through the annular protuberance, whence they proceed, taking the form of the great peduncles of the hemispheres of the cerebrum. These peduncles, being enlarged by the non-fibrous substance enclosed in their interior, continue to advance, and terminate in a great ganglion, or mass of non-fibrous substance, the optic thalami; there they are increased by the addition of the fibrous matter, a great part of which is distributed in a radiated manner towards the hemispheres, and the remainder to a third great mass of non-fibrous substance, the corpora striata; it there also receives a great increase of the fibrous matter. This fibrous substance there forms great nervous bundles, which, radiating similar to those of the second great cerebral ganglion, like a fan, towards the periphery of the hemispheres, is there spread out into a nervous membrane. This does not exist in a state of health as an extended membrane, but in folds, like a furlbelow, and thus showing the internal half of the convolutions and anfractuositities.

Such is the diverging nervous system of the cerebellum and cerebrum. All anatomists, who follow the progress of the science, have adopted this exposition of the structure, since our public demonstrations and the publication of our anatomy of the brain.

With the exception of the mechanical explanation of the formation of the convolutions and anfractuosit-ies, which I have already refuted, MM. Carus and Tiédemann profess the same theory. Therefore, it is not necessary for me to defend the diverging system against the anatomists.

But those, who have not seen the unfolding of the hemispheres of the cerebellum and cerebrum; those, who have not observed the different direction of the nervous fibres of both the cerebellum and cerebrum, obstinately reject the idea of a converging nervous system of these parts.

It is, therefore, this important part of the anatomy of the nervous system, that I shall once more endeavour to demonstrate.

Converging System of the Cerebellum.

It is certain that the nervous filaments always originate from the non-fibrous substance. Now, the whole surface of the lamellæ, branches, ramifications, and layers of the cerebellum, is covered by the same; this consideration itself should dispose anatomists, who are convinced of the stability of the laws of nature, to seek, in this non-fibrous and cortical substance, the origin of another order of nervous filaments, besides those which diverge in that direction, from the ciliary ganglion of the hemispheres of the cerebellum.

This probability is rendered certain, when it is found, that the fibrous substance of the hemispheres of the cerebellum, and of the annular protuberance, is too abundant to be furnished by its primary bundles and its ciliary bodies. This increase, then, must come from another source, that is, from the non-fibrous substance situated on the surface of the cerebellum.

In fact, when the direction of the primary bundles is examined, from the peduncles of the cerebellum, after having scraped the ganglion of the auditory

nerve, on the external edges of the fourth ventricle, it will be perceived, that they dip down into the interior of the hemispheres. It is entirely different as to the direction of the transverse nervous bundles of the annular protuberance. If the small lamellæ of the external border of the hemispheres of the cerebellum are separated, without tearing away any part with the finger, following always the direction of those large and broad bundles, and upon these same bundles, it will conduct us even to the extremities of the ramifications and the layers. Sometimes, even by this simple process, the whole cerebellum may be unfolded, in the same manner as is done in a dropsical state. It is, then, evident, that all the nervous filaments, which form the annular protuberance, are only the continuation of the primary bundles, but originating from the extremities of the lamellæ and ramifications, converging and uniting themselves to the same filaments of the opposite side, forming the reunion, junction, or commissure of the cerebellum. I refer the reader, who wishes for more detailed and scientific views on this subject, to my large work, vol. i. p. 258, in 4to.

Let us now hear M. Tiédemann: "The annular protuberance," he says, page 167, "composed of transverse fibres, originates from the middle or lateral cords, which surround the olivary and pyramidal bundles of the medulla spinalis, below which they unite together on the median line. These middle cords come from the corpora rhomboidea and the white substance of the cerebellum; so that they appear as soon as the medullary nuclei begin to form, that is, at the fourth month. M. Gall pretends, that they are produced by the particular fibres, to which he gives the name of reëntering (*rentrantes*) fibres, which, according to him, originate from the grey substance spread upon the laminæ, and especially upon the cerebellum, which, by uniting, form the great commissure or the pons Varolii. These entering fibres are imaginary things;

for, the annular protuberance and medullary fibres composing it, already exist in the fœtus of four months, that is, at a period when there are neither branches nor ramifications, nor even laminæ, which are covered with the cortical substance. M. Gall makes them arise from parts which are formed after them." Page 93, he remarks: "Other fibres also he derives from the corpus ciliare, which are spread without and in front, surrounding the olivary and pyramidal bundles of the medulla spinalis, and uniting together to form the annular protuberance."

If the transverse bundles of the commissure of the cerebellum are continuations of a part of the primary bundles of the cerebellum, why is it that these transverse bundles do not appear simultaneously with the first rudiments of the hemispheres? Why do they appear only at the fourth month, when the hemispheres of the cerebellum have already acquired a considerable development, that is, when the hemispheres are sufficiently developed to supply the new white fibrous substance? The direction of these new filaments is opposite to that of the filaments, which are the continuations of the primary bundles. Moreover, the latter diverge in their course, while the others, coming from the surface, constantly approximate, to form the commissure. When M. Tiédemann could deduce an argument against my assertion from the fact, that, until the fourth month, the lamellæ and layers of the cerebellum are not perceptible, I again answer him, that it is neither from the lamellæ, nor layers, &c., that I refer the nervous filaments, but from the non-fibrous substance. Now, I have already shown, how, M. Tiédemann is mistaken in asserting, that the non-fibrous substance is formed at a later period than the fibrous, and that the cortical is the last. He does not suppose, then, that the surface of the hemispheres of the cerebellum and cerebrum, is enveloped with the innumerable vessels of the pia-mater; and that these same vessels first secrete the gelatinous substance,

non-fibrous and here termed the *cortical substance*! He forgets what he so often repeats, that there is no difference between the cortical and the medullary substance, either in the convolutions of the cerebrum, or in the laminæ of the cerebellum, and that the exterior layer, which corresponds to the cortical substance, is of a reddish white, similar to the interior layer, which corresponds to the medullary.

It is evident from this discussion, that M. Tiédemann did not see correctly, when he thought he perceived, p. 114, that a middle peduncle came from each corpus ciliare, the transverse fibres of which surrounded the olivary and pyramidal bundles, and formed the annular protuberance, by their union with those of the opposite side. Let us now see, if he is more successful in his views of the great commissure of the hemispheres of the cerebrum.

Corpus Callosum, great Commissure of the Hemispheres of the Cerebrum.

The evidence, which I have just brought forward to prove the converging nervous system of the cerebellum, is also applicable to the cerebrum. It is equally to be presumed, that the non-fibrous substance on the surface of the hemispheres gives origin to other nervous filaments, as those which were expanded towards this same surface, after being reinforced by the great cerebral ganglions.

It is also certain, that the nervous bundles, which radiate from the two great cerebral ganglions or optic thalami and corpora striata, do not wholly supply all the white and fibrous mass of the hemispheres. This increase of the fibrous substance, this enlargement of the hemispheres must be derived from another source. And whence must it be derived, if not from the cortical substance of the hemispheres?

The following is the explanation of this increase or

augmentation of the hemispheres, according to M. Tiédemann. "The membranous hemispheres successively cover, in the fœtus, the corpora striata, optic thalami, tubercula quadrigemina, and lastly, the cerebellum as they are thus prolonged from before backwards; their volume increases by new layers of cerebral substance, which is secreted by the blood furnished by the vessels of the pia-mater. The radiating fibres, which constitute the base, increase in their turn in these depots, and others are applied to their surface, which, instead of inclining inwards, on the contrary go outward, and tend towards the circumference." Page 258.

I doubt very much, if any anatomist comprehends or adopts this hypothesis. Thus M. Jourdan was much puzzled to convey the meaning of M. Tiédemann. He thus expresses himself: *Die in die Hemisphären sich fächerförmig ausbreitenden Fasern der Hirnschenkel bilden sich in jene neue abgesetzte Masse fort, und es legen sich neue in die Peripherie sich ausbreitende Fasern an jene von aussen nach innen gekrumte Fasern an.* Is it not evident, that M. Tiédemann has here imagined things, which he could not see? And who will agree with him, that there are nervous fibres, which are not derived either from the optic thalami and corpora striata, or from the cortical substance of the hemispheres?

However the two orders of fibres do not pass unnoticed by him. He says, p. 86: "There is then a double radiation of fibres in each hemisphere. Some radiate directly from within outwards, while those of the internal surface have a direction, on the contrary, from above downwards."

It is probably this phenomenon, the explanation of which has been so difficult for him to adduce.

Before continuing my proofs, that the great commissure of the hemispheres of the cerebrum is formed by the fibres, which originate in the cortical substance, and which, by converging, unite the similar fibres of

the hemispheres, I will give the opinion of M. Tiédemann. "My works," he says, page 259, "confirm the results, which M. Gall has arrived at from his researches upon the course of the cerebral peduncles, through the optic thalami and corpora striata, as far as into the hemispheres and convolutions; but they refute all that this anatomist has said of his pretended system of reëntering fibres."

And also p. 264. "It is seen, that the corpus callosum is produced by the reunion of the fibres of the two cerebral peduncles, and after that they have expanded to form the hemispheres. The reëntering fibres, by which M. Gall has explained its formation, and that of the anterior commissure, are therefore things which have no existence. This anatomist pretends that the reëntering medullary fibres arise from the grey substance of the convolutions; that, in descending, they cross the ascending and radiating fibres of the cerebral peduncles, and that they afterwards converge towards the median line, where they unite to form the corpus callosum. But all these assertions are but mere hypotheses; for, the corpus callosum already exists in the fœtus of four or five months, that is, at a period when there are neither convolutions, nor layers of cortical substance, on the surface of the cerebrum. The pretended reëntering fibres therefore cannot have an origin from parts, which have no existence. But a positive proof of the incorrect views of M. Gall in this respect is furnished, by the uninterrupted connexion, which I have observed, between the medullary fibres of the peduncles and those of the corpus callosum."

M. Tiédemann, as we have seen, is forced to admit a double radiation of fibres; we have also observed this double direction of fibres, but could never discover, that the radiating fibres were reflected without interruption in their descent, and I challenge any one to show this fact; he, who proves too much, proves nothing. As we were convinced, that the non-fibrous

substance at all times throughout gives origin to the cerebral fibres, we have preferred to adopt the opinion, that this second order of descending fibres takes its origin in the non-fibrous substance, which, at every period, covers the surface of the hemispheres. Here, again, M. Tiédemann insists upon the convolutions, the existence of which he has not yet acknowledged. Here, also, I must again repeat, that I do not make the nervous filaments originate from the convolutions, but from the non-fibrous substance. Now, M. Tiédemann himself asserts, that before birth no difference is perceptible between the two substances; he even affirms, in several places, the existence of the pulpy non-fibrous substance on the surface of the hemispheres, p. 120. How then can he pretend, that the cortical substance is not formed until after birth? The corpora striata, also, do not appear until a later period, as composed of two substances perfectly distinct. Can he maintain that, in the first months, the non-fibrous substance has no existence in this great cerebral ganglion?

M. Tiédemann censures Reil, who, after my example, considers the transverse bundles of the great commissure, as aggregations of particular fibres, and wholly different from those of the cerebral peduncles. Reil saw our demonstration of the brain, and was convinced of the truth of this phenomenon. And I think that, if M. Tiédemann should witness one of our dissections, or rather one of our developments of the brain, he would soon become a believer in the two nervous systems, the diverging and the converging. In the mean time, I invite him to reflect on the following considerations, and to pursue our manner of dissecting the adult brain.

If the transverse fibres of the great commissure are continuations of the radiating fibres of the corpora striata, how could he explain why the commissure was not formed, as soon as the radiating fibres of the corpora striata and optic thalami were sufficiently extended to meet the median line?

Why does this commissure appear after the hemispheres have already acquired a considerable development, at the end of the third month? p. 262.

Why is it that the great commissure is formed from before backward, p. 264, while all the successive formations of the corpora restiformia and the peduncles of the cerebrum succeed each other from behind forwards? According to my views, the reason is evident: it is, that the transverse fibres of the great commissure are not continuations of the radiating fibres of the peduncles, but of fibres originating posteriorly, and coming from an opposite direction, arising simultaneously from the surface of the anterior lobes, which are the first, that acquire a considerable development.

Lastly, let us take an attentive view of the great commissure itself, and compare the direction of its fibres with that of the radiating fibres of the corpora striata.

After having scraped, either with the finger or with the rounded handle of a scalpel, the non-fibrous substance of the corpora striata in the lateral halves of the hemispheres, nervous bundles only are seen, more or less large, taking a direction forwards, inwards, and backwards, precisely like a fan, that is, diverging from the optic thalami and corpora striata towards the surface of the hemispheres.

Let us undertake to expose the external portion of this great mass of non-fibrous substance, which is done by pushing it gently with the end of the finger towards the anterior part of the corpora striata, and following it in its direction externally and from before backwards (an operation which unfolds a convolution, which surrounds this part of the corpora striata, and which is in contact without adhering to them): scrape in the same way this non-fibrous mass, raise the peduncles, and you see the large bands of the nervous bundles radiating in every direction, forwards towards the anterior, laterally towards the middle, and posteriorly towards the posterior lobes.

In this position, you have the internal surface of the great commissure in full view. This commissure being equally composed of nervous fibres, their direction is not difficult to discover. First, make a slight longitudinal incision in the middle of its length, and with the blade of a scalpel placed perpendicularly, separate the white mass, and you will perceive the transverse direction of all the fibres, which form the largest portion of the commissure. This direction might lead to the supposition, that these are the immediate continuations of the nervous bundles of the corpora striata, those in the centre, appearing to take a direction towards the median line: but the error is soon perceptible, when it is considered, that the bundles, proceeding from the corpora striata, are much larger than those of the commissure.

But how can it be comprehended, that the bundles, which take a direction inwards or towards the commissure, are not extended immediately into the commissure? Pass the fingers of the right hand between those of the left: it is in this same way, that the bundles of the corpora striata penetrate between the converging bundles, which come from between the diverging bundles, and go to form the transverse portion of the commissure, while the diverging are expanded more and more, to form the cerebral membrane and convolutions.

Now scrape the fibres of the commissure at the anterior and posterior extremities, and you will perceive another direction; you will find that, at the anterior extremity, the fibres, which go to the commissure come converging, from the anterior lobes, and that they cross the diverging fibres of the corpora striata, in a slanting direction. At the posterior extremity, the fibres, or rather the large nervous bundles, converge from the posterior lobes, cornu Ammonis, &c., taking a direction from behind forwards, and likewise crossing, in a slanting manner, the nervous bundles of the corpora striata, which diverging pass

from before backwards, consequently in an opposite direction to the diverging bundles; it is therefore impossible, that the former should be the direct continuations of the latter.

There is another circumstance, which evidently shows, that the converging bundles reënter the hemispheres, which M. Tiédemann has omitted to mention, because he could not explain it satisfactorily by his hypothesis. It is known, that the great commissure forms a fold anteriorly and posteriorly: and that, in these folds, the converging direction towards the commissure is very evident, principally from right to left. It remains for us to explain, how these folds are formed, &c. This explanation at the same time will give an idea of the disposition of the cerebral membrane, such as it exists in its natural state.

Take a half sheet of paper, a foot long and seven inches wide. Mark it with lines near each other, in the direction of its length from left to right, to imitate in some degree the white fibrils of the cerebral membrane. This white and ruled surface represents the cerebral membrane unfolded. There is no separation of the two halves, no opening, either anteriorly or posteriorly. The nervous fibrils, or the lines which unite the two halves (the great commissure) are extended horizontally through the whole width of the sheet. This should be the case of the two hemispheres of the brain, if they existed in an unfolded state.

In order to understand, how nature has formed the anterior and posterior slopes of the hemispheres, or their four prolonged angles, and the anterior and posterior folds of the great commissure, it may be imitated in the following way:

Fold the anterior and the posterior middle about an inch wide, but so that the four corners of the sheet remain spread out. Thus the paper will be doubled one inch in width in the two anterior and posterior middle parts, and there will be in the middle of the sheet

still three inches not folded. Therefore, there will be an interruption of the width of the great commissure, by its two anterior and posterior folds.

Then fold the two extremities of the right and left two or three inches wide, towards the median line, and this will give the slope formed by the four angles or wings of the hemisphere, and the middle folds. You will conceive how the ventricles or cavities of each hemisphere are formed; the oblong square three inches in length not folded, which remains in the middle, will represent the great commissure.

On examining the direction of the lines in the two folds, the fibrils of the cerebral membrane, you will see, that their horizontal direction, which is preserved in the length of the commissure, is changed. The lines take a direction from the four angles, returning obliquely from right to left, and from left to right, towards the median line.

After all this, place the circle radiating from the corpora striata, at the distance nearly of one inch and an half from the great commissure in the cavities, and you will be convinced that the lines, their bundles radiating like a fan, cross each other anteriorly and posteriorly, with the lines or entering nervous bundles of the folds; that, therefore, some of these bundles are not continuations of the others; and lastly, that the white fibrous substance of the hemispheres is composed of two layers, one of which is formed by the expansion of the bundles of the great ganglions, the optic thalami and corpora striata; the other, by the reëntering fibrils of the non-fibrous substance of the surface of these convolutions.

Anterior Commissure.

Page 230, M. Tiédemann says: "M. Gall regards the anterior commissure, as belonging to a system of organs composed of converging fibres, which he sup-

poses to originate from the grey substance of the cerebral convolutions. These reëntering fibres, or apparatus of reunion, are imaginary things. M. Gall says, that the anterior commissure is produced by fibres reëntering, which arise from the anterior convolutions of the middle lobes, and from some of those which are near the fossæ Sylvii, and that these fibres take a course from without inwards, so as by their reunion to produce the anterior commissure. The following facts prove, that he is also mistaken in this respect. The anterior commissure already exists in the brain of the fœtus of three and four months, consequently at a period when the brain has no convolutions; for, these do not appear until some time afterwards. It cannot therefore arise from the converging fibres of parts, which have no existence."

Can it be necessary again to prove the futility of an argument, deduced from the non-existence of the convolutions of the middle lobes? But the anterior commissure does not yet exist at the second month; M. Tiédemann has not observed it before the third; at first, it is very thin and delicate; but it increases gradually, in the ratio of the development of the hemispheres. Why does it not exist as soon as the radiating fibres of the corpora striata? It only appears at the period when the middle lobes are partly formed, and consequently covered by the pia-mater and the gelatinous, pulpy, non-fibrous substance.

"This is the manner," says Tiédemann, p. 229, "in which the anterior commissure originates: the cerebral peduncles, after having penetrated the corpora canniculata, expand their numerous medullary fibres into the hemispheres, many of which incline from behind forward, and from without inwards, connecting themselves in the form of a cord, and forming a union with those of the opposite side. The anterior commissure then is a medium of union, between the radiations of the two cerebral peduncles, the corpora canniculata, and the two middle lobes of the hemi-

spheres of the brain. M. Chaussier well understands the origin; as he makes the fibres, which form it, to come from the cerebral peduncles."

It would be interesting to know the means, which M. Tiédemann employed to discover the radiating fibres of the peduncles, expanded in the hemispheres, and inclined from behind forwards, and from without inwards, &c.; but let us refer to autopsy; this alone will refute all the ideas, which are in contradiction with nature and common observation.

After placing the brain on its convex part, turn up or remove the optic nerves, and you will perceive a white, nervous cord, of the size of a crow-quill. Scrape with the handle of a scalpel, or with the rounded blade, this non-fibrous substance, but without including the nervous cord or the anterior commissure itself. Follow the direction of the cord which goes, slightly curved in its course, from before backwards and towards the anterior part of the fossæ Sylvii. Then with the same precaution, raise the non-fibrous substance, until the whole surface of this cord is exposed. Having reached the anterior extremity of the middle lobes, you will see, that this cord begins to be divided into many minute cords, which penetrate into the fibrous substance, diverging, and, as the cerebral substance is but the cerebral membrane folded into convolutions, consequently into the convolutions of the middle lobes. It is therefore evident, that medullary fibres come from the convolutions of the middle lobes, which, approximating successively, form little cords, which, by converging and uniting, constitute the great cord, which therefore is the reunion, the junction, the commissure, of a part of the middle lobes. Through its whole course, this cord has no connexion with any other part, neither with the corpora striata, nor with the peduncles of the brain. To make this certain, cut it in the median line, and remove it carefully with the handle of a scalpel. Do this without tearing it, as far as its entrance into the middle lobes. In its

course, you will meet some nervous bundles, that you might suppose were connected with this cord, but, with greater attention, you will see that these bundles pass above, or, in this position, below, and that they come from the corpora striata. The cord being thus raised through its whole extent, leaves a groove in the non-fibrous substance of the corpora striata, which groove is perfectly smooth; which proves that there was no attachment, and that, consequently, it had no connexion either with the peduncles, or with the corpora striata.

Unfolding of the Hemispheres of the Brain.

The unfolding of the hemispheres of the brain will always be an insurmountable difficulty, a stumbling block to every anatomist, who has never seen this operation. In fact, this unfolding would be impossible, if the ideas of M. Tiédemann, respecting the structure and formation of the hemispheres, were correct.

The following is the manner M. Tiédemann explains the increase and structure of the hemispheres; p. 86, he says: "The vessels of the pia-mater, which envelope the cerebral substance, and which, no one will deny, are the organs that form and nourish this substance, separate from the blood which they carry to the encephalon, by means of ramifications detached from the internal surface of the membrane, the new cerebral pulp or mass from which it originates. This pulp then is arranged *in layers from within outwards*; it *crystalizes*, if I may use the expression, *under the form of fibres, which connect themselves to the surface of the primary fibres*. The walls of the hemispheres acquire greater thickness by the increase of the pia-mater, and by the successive depositions of new layers upon the old. An examination of the cerebral substance furnishes proofs in support of the opinion I

have advanced. When the pia-mater is detached from the encephalon, *layers, more or less thick, of the cerebral pulp*, remain adherent to its internal surface, which is evidently in consequence of the soft exterior substance, which is the last deposited, adhering still to the vessels belonging to the internal surface of the membrane. The layer which is adherent to the parts of the pia-mater, which have been detached, and the superior layer of the brain, deprived of this envelope, are both equally soft, and exhibit no fibrous appearance. Examined with a microscope, they appear to be composed of very minute globules. If the brain is torn, fibres are seen, on which is a layer of soft substance, and without a fibrous texture. This substance, *which is secreted the last, has not as yet been sufficiently matured to take the form of fibres*. Perhaps it may be said, that it corresponds to the cortical substance; but this objection has no force, for the cortical substance is not deposited on the surface of the brain until after birth."

The reader must be surprised at the efforts made by M. Tiédemann, to sustain his prejudice against the origin of the nervous filaments of the non-fibrous and cortical substance. It is hardly possible to make concessions more explicit in favor of my proposition. At all periods of life, this soft and non-fibrous substance adheres to the pia-mater; how can he know, then, that it has been the last to be secreted? To crystalize, not to have had time to take the form of fibres, &c., truly are dreams unworthy of such an anatomist as M. Tiédemann! There is no doubt, that the substance, which is soft and without fibrous texture, corresponds to the cortical, and, if it does not appear as a substance different from the fibrous substance, until after birth, it is because that, in general, both externally and internally, the two substances become more distinct, in proportion as the soft substance diminishes, after it has given origin to the white fibrous substance, and confined itself to the limits prescribed by the various periods of life.

All, who have seen the hemispheres unfolded, know that the cerebral membrane is, throughout its whole extent, of nearly the same thickness; that the external layer of the cortical substance equals in thickness the internal substance of the fibrous matter: how can this fact be reconciled with the idea, that the hemispheres, at first thin and membranous, gradually increase in thickness by new layers, disposed from within outwards, of soft pulpy substance, which finishes by crystalizing in fibrous substance, and by applying itself to the surface of the primarily formed fibres?

Would it not be better to say, that the fibrous substance of the hemispheres increases, in proportion as the non-fibrous, (whether of the optic thalami and corpora striata, or that of the surface of the hemispheres,) is successively secreted more abundantly, and gives origin to a greater quantity of nervous substance?

Let us follow the opinion of M. Tiédemann on the structure of the hemispheres, and on the origin of the convolutions and anfractuositities.

He says, p. 164: "The pia-mater, gradually increasing in extent, forms folds, which dip down into the soft and cerebral matter of new formations; from this, the transverse furrows and the lobules, which are perceptible at the fifth month, are derived, also the division of the cerebellum into branches, which lie upon the medullary nuclei. These formations are constantly in action, and the pia-mater also extends itself: this, again, produces new folds; then the transverse furrows become more numerous, and the branches divide into more minute ramifications, which takes place towards the age of six months. At the seventh and eighth months, the cerebral matter is secreted in very great quantity; the pia-mater yet forms again deep and superficial folds, which penetrate more or less, and lobules, branches, and ramifications not only appear, but also the minute distributions and layers.

Lastly, at the ninth month, there is deposited on the surface of the medullary leaves, a layer wholly external to the cérébral substance, filled with a number of vascular flocculi, having the appearance of velvet. Consequently, the cortical substance is applied to the surface of the cerebellum from without inwards, and it is the last production of the pia-mater."

So much for the cerebellum. And now we see as much even for the brain. Page 103, he says: "The fibres of the hemispheres being covered in a fœtus of seven months with a layer of soft substance, which adheres to the internal face of the pia-mater, into *which the folds of this membrane sink*;" and, page 259, he insists in saying: "The earliest rudiments of the convolutions and anfractuosities, that are perceived here and there in the fœtus of four months, take their origin from slight duplicatures of this membrane of the hemispheres. Most of these grooves and convolutions are formed during the last months of pregnancy, in consequence of the increase of the pia-mater, which, in enlarging, bends and sinks its folds into the soft layer of cerebral substance, which covers the external portion of the hemispheres."

I appeal to the good sense of my readers, and of M. Tiédemann himself, to treat, as it deserves, this mechanical explanation of the formation of the branches and laminae of the cerebellum, and the convolutions and anfractuosities of the brain. The pia-mater is not a membrane, which, in compressing the brain, would make notches on its surface; it is a tissue of sanguineous vessels, destined to nourish, penetrate, accompany, and to excite to activity the two cerebral substances. The greatest number of these vessels, is distributed in the non-fibrous pulpy substance, placed as well within as without; the rest follow the nervous fibrils in their whole course. Let us suppose, that the tissue increases, that it forms folds. What is there that will oblige it to sink into the white fibrous substance? What establishes these depressions in such a

way, that, in the same species of animals, the same convolutions and anfractuosities constantly occur, perfectly symmetrical in the two hemispheres? What is it, that produces the folding of the leaf of corn, while it is yet enclosed in the stalk? What is that, which produces the depressions and elevations of the kernel of the nut? The same thing, which produces the convolutions and anfractuosities of the brain; a primitive law of the organization, an inherent tendency in the germ; this prevents us from wandering in the labyrinth of chimeras.

How will Tiédemann persuade us, that the cortical substance is the last production of the pia-mater? He so frequently tells us, that the pia-mater every where secretes a non-fibrous pulpy substance; that, in tearing off the pia-mater, this substance remains adherent to it, in the form of flakes. Is it not, at the present time, advancing a hazardous assertion to say, that this same substance is not the same with that, which is observed later under the form and name of cortical substance? If the skin of an animal, the rind of a fruit, the bark of a tree, are placed in the surface, are they, on that account, applied from without inwards, or from within outwards, and are they the last productions of the vascular system?

Thus, all, which Tiédemann has imagined, respecting the formation and structure of the convolutions of the brain and the laminæ of the cerebellum, is entirely contrary to the course of nature. But his ideas enable me to comprehend, how he honestly believes, page 260: "That I am deceived, when I admit that the convolutions of the cerebellum are the result of the folding of the membranes, under that form which the hemispheres originally present; and that the method that I employ to prove, that the hemispheres may be unfolded and brought back to the condition of a membrane, always causes a tearing of the internal laminæ of the cerebral peduncles; that is to say, of those which curve from without inwards, and on this account are by no means conclusive."

Where *facts* speak, reasoning is superfluous. It is true, I have little confidence in the information that I can give, to enable one of himself to unfold the hemispheres. Yet, besides referring to my large work, Vol. I., and to our answer to the Institute of France, I shall here add some remarks.

I have said, that, after having scraped the non-fibrous substance of the corpora striata, we see very distinctly the diverging fasciculi sink deep between the converging fasciculi, which form the great commissure. In this place, there is an interlacing and decussation of the fibres. If we commence scraping at the middle line of the commissure, we can very easily follow the transverse direction of its fibres to this point. But here we are stopped, unless we force and break this interlacing. However, when we take the hemispheres, without this point, the unfolding is effected without any tearing of the fibres. The way to proceed, in order to succeed, is in this manner: we cut either a whole hemisphere, without the optic thalami and the corpora striata, or a part, for instance, the middle or posterior lobe. We begin by removing the pia-mater, and, for the greater facility, we prefer a brain where the pia-mater can be detached without tearing the convolutions, which frequently happens in brains, that are inflamed or much softened. After having removed the pia-mater, the convolutions often separate and flatten so much, that we already foresee the possibility of making them entirely level; the cerebral portion is inserted, that is to say, the convolutions on the left hand. It is well to commence on the edges, for there we see the middle of the convolutions. We proceed, lightly pressing the finger on this point, and by degrees, gently applying the force, the convolution separates into the two laminæ of which it is composed. In this way, we unfold the whole circumference of this portion. Soon we perceive small grooves, which correspond with a convolution; by pressing several times in the same

manner, with the finger on one of these grooves, it will flatten, as the convolution is unfolded: or rather take a portion of the brain on the fingers of both hands; press gently from below with three or four fingers, and from above with the thumbs on the convolutions, bearing either externally upon the convolution or internally on the grooves, in a short time you will have only a membrane, smooth and white internally, and covered with a grey substance externally, of nearly a line in thickness, or a line and a half. The proof, that there is no tearing, is, first, that the internal surface is entirely uniform, and, in the second place, the small sanguineous vessels, which exactly follow the direction and fold of the nervous filaments, are unbroken.

By practice each one will discover the process, which he will succeed with, best. But those, who have no patience, or who are not possessed of a certain degree of dexterity, will be constantly obliged to have recourse to others, already versed in this artificial process. Hydrocephalic heads afford an excellent opportunity of observing the natural unfolding, and of proving its reality. But unfortunately, those cases, which have already effected the conviction of many anatomists, are yet neglected by others with unpardonable indifference.

Soon there will not be a single university, where there will not be one or many individuals, who have been present at this operation; now as easy, as wonderful.

Conclusion.

I have left untouched many disputed points of the work of Tiédemann; for the present, it was only necessary for me to refute, what he and his partisans considered as essential to overturn my principles of the comparative anatomy and physiology of the brain. My readers must have perceived, that I have almost

always taken the observations of Tiédemann himself, to demonstrate my propositions; and it is particularly in this respect, that his researches on the brain of the fœtus are extremely valuable.

As to the successive formation of the different cerebral parts, and the utility of comparative anatomy, we perfectly agree. As far as the comparative physiology of the brain is concerned, I believe that I have partly accomplished the wishes of Tiédemann. The facts, cited by him, have become for me so many confirmations, that the pulpy, gelatinous, non-fibrous substance of the nervous system, is the first secreted by the sanguineous vessels: that it is constantly in the spinal marrow, in the brain, in the nerves of sense, an apparatus, in which the nervous filaments take their origin, and where they receive their supplies.

Tiédemann, notwithstanding his dislike for the converging and diverging system of the brain, has himself been compelled to admit this double radiation of the nervous fibrils, on which we have based our opinion. Thus all our difference is reduced to the question, whether the nervous fibres of the peduncles of the brain, the optic thalami, and corpora striata, after being spread out in the hemispheres, curve uninterruptedly from without inwards, to form the commissures; or, whether the non-fibrous substance of the surface of the brain, that which is here called cortical, gives origin to this other radiation of the medullary fibrils? As it is impossible to prove the uninterrupted continuation of the diverging radiation; as the cortical or non-fibrous substance every where gives origin to nervous filaments, and as, without this supply of non-fibrous substances, the fibrous mass of the hemispheres could not much exceed that of the optic thalami and corpora striata, we have adopted the last opinion, which is also evidently confirmed in the commissure of the cerebellum, in the anterior commissure, and in the great commissure of the hemispheres.

I have demonstrated, that the ideas of Tiédemann, on the structure and formation of the convolutions of the brain, and the laminæ of the cerebellum, were erroneous, that these errors have prevented him from conceiving the possibility of unfolding the hemispheres of the cerebellum and brain.

Finally, I have believed, that I could facilitate this operation with the incredulous, in giving them an idea approximating in a trifling degree to the summary arrangement of the hemispheres of the brain, by folding a bit of linen or square paper, nearly in the same manner as the cerebral region is folded and rolled upon itself.

I have then disposed of all the obstacles which, in the eyes of anatomists less versed in the anatomy of the nervous system, could yet throw some doubts on my principles of the anatomy of the brain. But let us admit, for a moment, that the fibrous substance of the nervous system, does not derive its origin or its increase from the pulpy non-fibrous substance; let us admit, that there does not exist any diverging radiated fibres, coming from the three grand cerebral ganglia, and converging radiated fibres going from the grey substance, which covers the external face of the cerebral membrane; let us admit, that all this, and the unfolding of the hemispheres into a nervous membrane, covered with a layer of non-fibrous substance, are all chimeras; what would result from this for the physiology of the brain? Would the conclusion be, that such or such other part of the brain does not exist? That the different parts are not susceptible of a different development and energy? That the mechanical aptitudes, the instincts, propensities, and faculties do not increase in proportion as the cerebral organization is more perfect? Would it follow, that the moral qualities and intellectual faculties are not innate; that their manifestation is not subordinate to material conditions, to the brain; that the different instincts, propensities, faculties, are not among them-

selves essentially different, and consequently require different organs? and so on.

The physiology of the brain ought not to be in opposition to anatomy; this ought even to come to the support of it. But physiology has been found independent of anatomy. Nothing in the physiology of the brain has been constructed on any anatomical data whatever; nothing has been interpreted by the structure or the arrangement of the cerebral parts; the anatomy of the brain has only served as a confirmation of the physiological discoveries. These discoveries are solely due to observation, to observation a thousand and a thousand times repeated, and it is only by this, that it can be judged, refuted, or confirmed. Thus, instead of having recourse to untenable subterfuges, instead of reasoning and declaiming, we must observe; the physiology of the brain disclaims every other method: it was produced, it has grown, and it will flourish under the shield of observation.

Elementary Principles of Physiology; by CHARLES ASMOND RUDOLPHI, &c.*

After having rectified the ideas of Tiédemann, the justly celebrated professor of the university of Heidelberg, I ought to do the same with respect to those of Rudolphi, who also enjoys a great reputation at the university of Berlin. I will only refer to those assertions in his work, which he opposes to my physiology and anatomy of the brain.

It is frequently the case with M. Rudolphi, as with all my adversaries, that he maintains certain errors, either by adopting them from others or from hear-say evidence; it is thus that, § 251, he asserts, that

* Grundriss der physiologie von Karl Asmund Rudolphi, prof. d. Med. et Physyl. d. Königl. Akad. d. Wiss. Zweyter Band. Erste Abtheilung. Berlin 1s23.

the brains of the smallest carnivorous animals are the type of the largest; that they all have convolutions; in the rodentia, on the contrary, says he, they are all wanting. The convolutions are the folds of the cerebral membrane; they should then always occur, when the brain is at all complex. Let Rudolphi examine the brains of the kangaroo, the beaver, &c., and he will find the most distinct convolutions.

This professor has adopted the opinion of Tiédemann, wherein he regards the convolutions as the simple result of the dipping in of the vascular membrane to the cerebral mass. I have just exposed the absurdity of this mechanical idea, which is directly opposed to the procedure of nature. How, on this supposition, can they conceive, that the sanguineous vessels of the vascular membrane, every where accompany the nervous filaments of the white substance? But Rudolphi admits this false assertion, since he believes, that he can infer from it, that my theory on the folding of the cerebral membrane is contrary to the arrangement of the brain. "I have tried," says he, "all the manipulations indicated by Gall, in order to unfold the brain, and I have always found, that this cannot be effected but by severely lacerating it, and that the convolutions are never unfolded in a regular and natural manner, as he pretends." Rudolphi affirms, even, that he has dissected with the greatest care two hydrocephalic brains, and that he has seen nothing like this unfolding; he has only observed that the superior parts of the brain were thinner than natural, and he explains it in this manner: "the action of the accumulated water," says he, "is not so strong towards the inferior portions, where the cranium opposes a greater resistance, in consequence of its increased thickness; but it is more powerful upon the superior bones, which are more movable, and consequently yield more easily; so that the membranes and the brain become very thin in these situations; on the sides, on the contrary, and at the base of the cranium,

they remain thicker. This is certain; and Walter, Sœmmerring, Ackermann, &c., have been perfectly correct in denying the pretended unfolding of the hemispheres."

Nothing is easier than to augment the list of celebrated men and professors, who teach their pupils, that the unfolding of the convolutions of the hemispheres into a uniform membrane is absolutely impossible. They suppose, that the white fibrillæ are directed perpendicularly towards the convolutions, which would really oppose an invincible obstacle to the unfolding; but examine a large hydrocephalic head, you will see nothing torn there; but you will see, that the radiated nervous fibrillæ of the great ganglions pursue a diverging direction forward, backward, laterally, downward, and upward, precisely like the small sanguineous vessels; that they thus form the internal, white, uniform layer of the cerebral bladder. When the water is evacuated, you can fold and unfold this same membrane, without deranging or tearing any fibrils; since you only fold or stretch the membrane, which is the result of the unfolding, naturally brought about by the action of the effused fluid in the cavities of the hemispheres.

Those, who cannot succeed in this artificial operation, certainly have a right to say, that they have not been able to convince themselves of this by their own dexterity; but to hear them, one would believe, that they accused me of imposture and charlatanism. But I repeat what I have said in the discussion of the same subject, in the work of Tiédemann; I invite Sœmmerring, Rudolphi, Blainville, &c., &c., to come and see with their own eyes this unfolding, which is so inconceivable, and, in the course of half an hour, they will be enabled to do it with as much promptitude as myself. This has fortunately happened to a number of young physicians, who did not suppose, that they were sufficiently learned to reject with impunity one of the most important discoveries in anatomy. If, even

in the two hydrocephalic cases, Rudolphi has not been able to discover the unfolding of the hemispheres, after having been so correctly informed of them, let him recollect the *dictum* of Vicq-d'Azyr, that, in order to see well in anatomy, something more is requisite than two eyes. Walter of Berlin also maintains the same opinion, founded on hydrocephalic cases, all the entire crania of which we saw unopened in his museum.

§ 252, Rudolphi also doubts, whether the nerves of the vertebral column derive their origin from the grey substance, placed in the interior of the spinal marrow. We must also admit, that he has not seen this anatomical fact; but we have seen it, and so well too, that in carefully drawing out the moderately strong nervous fibres from the longitudinal grooves from which they arise, there remains a small bulb of this grey substance adherent to them. There is but a single law for the origin and increase of the nervous fibrils; every where they arise from and strengthen themselves with the grey substance, which is not fibrous. This is evidently seen in the annular protuberance, in the *soi-disant* optic couches, and corpora striata, in the bulb of the olfactory nerve, in the grey band of the auditory nerve, &c., &c., and in approaching nearer the spinal marrow, we can see most distinctly the third pair, forming its trunk from filaments, which come out in a converging manner from the black substance, situated within the bifurcation of the cerebral crura. Finally, why does there always exist a more considerable collection of grey substance in those situations, where the spinal nerves arise, and why is it that this non-fibrous, grey substance is always in proportion to the size of the nerves, arising from it? But I forget that these protuberances, of which the nervous system of voluntary motion is composed, from the caterpillar to man, have not been seen by a great number of celebrated anatomists, and that this same grey substance, having at first only the consistence of

a transparent fluid, has not been admitted as such by Tiédemann?

It is especially at § 253, that Rudolphi discovers his knowledge of the organization of the brain. He admits, that the fibrils come from various directions to the annular protuberance; that, from this part they are continued to the optic couches, the corpora striata, and the lateral masses of the brain. Then he believes, that these horizontal fibres of the great commissure go to the hemispheres; that, from this commissure, the laminæ of the septum descend towards the fornix, which itself forms many connexions by means of its relations (*Mit seinen Schenkeln*); that the cerebellum, organized in a particular manner, dips into the annular protuberance by means of many horizontal bands; that this same cerebellum appropriates to itself a part of the fibrils of the medulla spinalis, and connects itself with the brain by means of particular fibrils and lamellæ. "Finally," says he, "if we regard the tuberculæ quadrigeminæ and their connexions; the pineal gland with its prolongations; the appendix of the brain, &c., &c., we shall observe such a connexion of fibrils, as will authorize us to believe, that these same fibres never change their direction. On the other hand, I believe that we shall find there a very important argument for the unity of the brain; for, there exists here a much more intimate interlacing than in the muscular fibres of the cavities of the heart, and in no point are they separated, as in the cavities and auricles of this last organ."

We perceive how defective and confused are the ideas of Rudolphi on the organization of the brain. We have here no connexion in the direction of the nervous fibrils; sometimes, he considers the brain from above downwards; sometimes, from below upwards; no law for the origin or increase of the white fibrous substance; in general, we perceive vague, erroneous, vacillating, contradictory, and indigested notions; and, after having spoken of the different, very distinct,

and separate parts; after having recognised the different directions of their fibrils; after having admitted, that the direction of these same fibrils is exactly the same; after having adverted to many very distinct portions, entirely separated from each other, he falls at once into the conclusion, that the brain is but a single organ in all its parts, where all is mingled and concentrated in a single uniform mass! This wonderful logic recalls to my mind that of M. Richerand, in his new *Elements of Physiology*, eighth edition, Vol. x. p. 166. After having said, that we can conjecture with a good deal of probability, that each perception, each class of ideas, each faculty of the understanding, belongs to such or such part of the brain; after having maintained, that it is impossible to study so combined an arrangement of the different integral parts of the brain, and to believe that it is not the effect of design, and that this division of the cerebral mass into so many distinct parts, so differently formed, does not relate to the different part, that each ought to perform in the mental operations; after all this, M. Richerand has also found there a strong argument, to prove the frivolity of my doctrine of the plurality of cerebral organs. It is thus, that great geniuses of all ages agree. Rudolphi asserts with Richerand, in a note to the same paragraph, that in different individuals, certain parts of the brain are more or less developed, and that the differences in dispositions and faculties probably depend on modifications of the development of different cerebral parts. Is not this language equivalent to an admission, that the different integral parts of the brain have each a different function?

Notwithstanding this vacillation, Rudolphi persists, § 263, in denying, that the brain is an aggregate of different organs. He says, that he has compared the external signs of the organs, with the convolutions which correspond to them, and that this comparison has shown to him, that, sometimes, many convolutions

belong to the same function, and that, sometimes, the functions of other convolutions are unknown.

We ourselves have very often compared the external form of an organ, with the cerebral part, the considerable development of which has produced this form, and we have always found a perfect correspondence between them, as I have frequently said in this work ; but I have also said, that I did not as yet know the functions of all the cerebral parts ; that, consequently, there were discoveries yet to be made ; finally, I have more than once avowed, that it was as yet absolutely impossible for me, to circumscribe exactly the extent of each organ ; I have even urged this consideration with those, who have believed that, in removing such or such parts of the brain, they would be enabled to learn its function.

"Let any one show Gall," continues Rudolphi, "the organs of robbery, murder, religious sentiment, separated from the cerebral mass ; certainly he cannot do it." Let any one show Rudolphi portions of the medulla spinalis and oblongata ; certainly he cannot distinguish them ; it has been, however, well demonstrated, that these parts are aggregates of different nerves. But still, this argument has enabled me to demonstrate, that it is impossible to learn from an inspection of the brain, the function of any cerebral part whatever.

When Rudolphi speaks of the different functions of the pineal gland, the corpora striata, he implicitly admits the plurality of the cerebral organs. On the other hand, notwithstanding the most definite answer that I have given to his former objections, he is not, as yet, able to understand the difference that exists, between an entire organ, and the different apparatus which compose it. He, who attributes another function to the different origins of the optic nerve, than that of concurring to the formation of the optic nerve itself, — to the bulb of the olfactory, another function, than that of serving to the formation of the

olfactory nerve, shows that he is altogether a stranger to the laws of organization of the nervous system.

In the notes to the same paragraph, Rudolphi still, as formerly, denies, that the brains of animals are less complicated than the brain of man; and, § 225, he has maintained, that in animals the cerebral part placed behind the forehead, and a great portion of the posterior lobes, are wanting. Mistakes of this kind can only be committed, when we are pursuing a false path. For an answer to all this, I refer Rudolphi to Vol. II. page 368, edition in 8vo., and Vol. II. page 367, 4to edition.

It is in vain, that we demonstrate to the adversaries of the plurality of organs, that, from the lowest species of animals up to man, the cerebrum becomes more and more complicated; in vain do we show them the brains of fishes, amphibious animals, the mammalia, and, among these last, those of the inferior and superior species; those of carnivorous and frugivorous animals; in vain do we point out to them that of the monkey, where the convolutions, both anterior and lateral, are much less numerous than in man; in vain do we prove to them, by comparative anatomy, that the brains of animals are so much less complicated, or, that there are as many natural mutilations in them, as the number of their instincts, propensities, and faculties, diminishes. Obstinately bent on explaining the simplicity of the *moi*, they see in all these incontestable facts nothing but a diminution of the simple cerebral mass, which, according to them, is absolutely the same, belonging to the same function in all its parts, in all animals and in man. Rudolphi supports his position, by referring to the brain of the embryo before even the convolutions are formed. I will admit this proof, so soon as Rudolphi shall have shown me the brain of an embryo, that has possessed any moral quality or intellectual faculty. If, however, Rudolphi wishes to adduce the brains of embryos, he ought also to recollect, that Carus and Tiédemann prove de-

cisively by them the greater or less complexity of the different brains of animals, and that they maintain, that the brain of the fœtus successively passes through the different degrees of composition of the different species of animals, until that, which may be, for instance, the brain of a fish, shall come, by the successive development of new parts, to the condition of the human brain.

It is in this way, that Rudolphi flatters himself, that he has refuted my anatomical proofs of the plurality of the organs. Yet he has passed in silence, not only a third proof, but also a great number of objections with my answers.

Among the physiological proofs, he does not admit, that the instincts, propensities, and faculties, that are essentially different, require different organs. "Who knows," says he, "who can affirm, that this is necessary, and that the mind has need of different cerebral parts? Perhaps a larger brain, being a more powerful apparatus, is sufficient for it." The cerebral apparatus is heavier and more powerful in the elephant and the porpoise; would Rudolphi measure the energy of their minds? Can we not ask, with as much reason as the metaphysicians maintain, who knows, who can affirm, whether the mind, that pretended independent agent, has need of any cerebral mass whatever? A transcendental philosopher is assured, from the knowledge that he has of the soul, that the mind of Newton would have performed the same prodigies, had it been placed in the brain of a frog. Rudolphi does not believe this, considering the weakness of the apparatus. Neither does he think, that we should compare beasts with man. According to him, it is only the mind of animals, that requires different cerebral parts for the manifestation of their different mechanical aptitudes, their instincts, &c. For man, the Creator would have been able, perhaps ought, to have constituted his mind, entirely independent of this vile, inert matter.

I have mentioned, as a second physiological proof, that one species of animals is endowed with qualities and faculties, of which another species is deprived; which would be impossible, if the whole cerebral mass was but a single organ, or rather, if each essentially different function, was not peculiar to a particular cerebral part. "But," says Rudolphi, "these particular parts are no where demonstrated." This professor manifests by this, that he has never compared two brains of two different species of animals. Let him compare the brains of the dog and cat, he will perceive quite a different number of convolutions, a totally different arrangement; let him compare the middle lobe of the brain of the ox, the middle lobe of that of the dog, wolf, tiger, &c.; let him compare the brain of the hen with that of the crow, the brain of the pigeon with that of the hawk, and, if he does not constantly find the material cerebral cause of the difference of their instincts, in accordance with my discoveries, if all comparative anatomy does not disclose to him a difference in the brain, where there is a difference of instinct, I will console myself for his blindness, in saying: *non omnia possumus omnes*.

We are not now speaking of modifications of the same quality, for instance, the singing of different species of birds; the question is of the instincts, propensities, and essentially distinct faculties, such as I have ascertained them. Is there a single organ in the living organism, which governs two essentially different functions? Does the auditory nerve see? Do the kidneys secrete bile? the stomach, respire? I see one animal without eyes, hence I conclude that he does not see; in another, I find no olfactory nerve, I conclude, that he is deprived of the faculty of smell, &c.; if I see different species of animals, some of which build and others do not, some of which sing and others do not, the metaphysicians complain, that I suppose in some, the existence of organs of which others are deprived.

"If these organs exist," says Rudolphi again, "animals cannot be changed by instruction." As I have fully answered all these objections, I refer the reader to the previous volumes. Now it remains for Rudolphi to prove, that all the species of animals, either have a different mind or soul, or, that they all possess, either by nature alone or from instruction, essentially the same qualities and faculties, always proportioned, as it respects their energy, to the mass of an homogeneous brain in its whole extent.

My third physiological proof: — the qualities and faculties, which are found in all individuals of the same species, exist in these same individuals in very different degrees; which can only be explained by the different degree of development and activity of the different organs of these qualities or faculties. "But," Rudolphi opposes to this, "we see, in all individuals of the same species, the same cerebral parts; and we see no difference, except as to the mass in general, or in certain parts of it." In this objection, Rudolphi seems to admit, that the brain is only the same in different individuals of the same species, and not in all species, as he has just maintained. He is right; since the qualities and faculties are essentially the same in individuals of the same species, their brain ought to be essentially the same. He is again correct, when he says, that we see no difference, except as it respects the mass in general, or in certain places, that is to say, in certain parts; which means, that such or such organs are more or less developed, according as certain qualities or faculties of these individuals, are more or less energetic. Already once before has Rudolphi made a similar confession; how does such a conscientious admission accord with denials, so formally made on the same subject?

Thus compelled to make certain concessions, as it were, by surprise, Rudolphi appears to solace himself in saying, that we do not know the signification of these individual differences. No one will dispute this

with him, provided he only speaks of himself and the adversaries of organology; still, these differences have a signification; and are they not of sufficient consequence to engage anatomists in their study? And if Spurzheim and myself, and so many others, affirm that we have learnt to interpret these differences of development of the different cerebral parts, would it not be decorous, instead of denying, with such haughty superciliousness, such interesting relations, to examine without prejudice how far observation confirms my pretended discoveries?

In my fourth proof, I have developed the following proposition: in the same individual, the different primitive and fundamental qualities exist in different degrees; which would not be the case, if each primitive quality did not depend upon a particular organ.

"But," says Rudolphi, "this difference of propensities and faculties does not take place, as a general rule. Whoever is eminently a man of genius, as Goëthe, for instance, has brought to perfection every thing that he has undertaken with ardor, whilst a feeble intellect is never distinguished. They talk of great musicians, who in all other respects are extremely limited in mental capacity; but, if they really were great musicians, they would not be so; they perhaps devote themselves entirely to music, and neglect all other pursuits. The cunning man deems all those foolish, who take no interest in his craftiness, or that despise it. There always exists a certain equality of faculties and propensities, provided we do not judge by the superficial opinions of the multitude."

Rudolphi, in this objection, is not correct. It is certain, that those and even great geniuses, who devote themselves exclusively to a single object, are necessarily very ignorant in other respects. In this manner of expression, people generally confound knowledge, instruction, or erudition, with innate talents. The greatest musicians may be ignorant of the first rudi-

ments of history ; the greatest poets may likewise be totally ignorant of the first elements of mathematics, and so on ; but this lack of knowledge does not prove, that musicians and poets are incapable of learning history and mathematics. Neither will it be denied, that an eminent genius, as we usually understand the word, genius, can unite in himself many eminent dispositions, and excel in many dissimilar things ; as a proof of this, we have Goëthe, Voltaire, Haller, &c. &c. Let us not, however, forget that many occupations, apparently very unlike, require the employment of nearly the same moral and intellectual powers. The faculty of observation, the force and promptitude of the judgment, prudence and circumspection, the exact knowledge of external data, constitute equally the genius of the physician, the general, and the diplomatist, &c.

But nothing is more true, more constant, than the different degree of the propensities and faculties in the same individual ; not a single man, not a single animal, is an exception to this. In bringing forward this proof, I wish first to direct the attention to the different power of the external senses. The same individual, that possesses excellent vision, may have the hearing or the sense of smell, very feeble. The most quarrelsome dog, that bites at every one, has often not the least propensity for the chase ; another, on the contrary, is the mildest and most peaceable animal in the world, and yet he is devoured with the desire for hunting and killing ; a cowardly bitch, without any instinct for the chase, passionately devotes herself to her young ; another abandons them with indifference, and defends the life of her master at the risk of her own. If Rudolphi denies these facts, so generally known in natural history, are we not justified in saying, that, notwithstanding his inexhaustible erudition, he is greatly wanting in the talent of observation, or is it because he has never lived intimately with any animal ? Among animals, he certainly will not say

that *perhaps* such a dog, horse, cat, respire but for a single object.

Animals, pretends Rudolphi, prove nothing as it respects man ; — well, animals require many organs for the difference of their instincts ; who knows, if the mind of man requires organs at all ? But it is useless to insist again on this last point ; let us see if man manifests the same phenomena, as animals.

If you have ever been a parent or teacher, you cannot have failed to remark, that such a child or pupil has certain predominant intellectual or moral dispositions, which cannot rationally be accounted for, either by education or preceding exclusive application ; that, in many instances, it is even impossible to divest these children of their natural tastes and inspire them with others ; it is even the earliest foundation of a good education, to learn and profitably manage the strongly marked dispositions of children. Every day we see young people, who have an astonishing faculty of learning by heart, and who are wanting in intelligence ; others, who are remarkable for their intelligence, but have great difficulty in committing to memory : such an one has a good memory for dates, and none for localities ; another forgets individuals, and remembers a concert, &c. &c. There is not a single individual, even of the most limited capacity, that does not disprove the assertion of Rudolphi.

Furthermore, if this professor would come to the determination to observe the organization of the brain and head, he would sometimes see an individual, in whom the anterior region had acquired a very great development, and the posterior region, on the contrary, a very small one ; sometimes he would see another individual, in whom quite the contrary had taken place ; he would see other individuals, in whom one cerebral part predominated, and another was arrested in its development. This method is the only one, that will explain the difference in the propensities and faculties in the same individual, and which absolves us from

the necessity of referring to the biographies of all the great men, and of having recourse to *perhaps's*, sophisms, assertions, and gratuitous denials.

Finally, since Rudolphi admits, that there are men of genius and fools, and that these last, with all possible care, can never rise above mediocrity, is it to a good or evil caprice of their mind, which *perhaps* does not require organs, that we must attribute this difference? As it respects men of genius, will Rudolphi maintain with M., H., or Z., editors of the *Journal des Debats*, that it is fathers, teachers, sovereigns, that make great musicians, architects, painters, poets, generals?

Fifth proof for the plurality of the cerebral organs : the essentially different functions of the brain do not manifest themselves simultaneously, either in man or animals. Some are constantly observed, while others appear or cease to be manifested, as they are influenced by different seasons or ages, which phenomena could not occur, if all the functions depended on a single or homogeneous organ.

Rudolphi brings forward, for the third time at least, the same objection to this proof: "the child," says he, "begins by receiving impressions; it is only after he has seen much or read much, that he can commence comparing and judging; judgment then will be subsequent to impressions; for, he supposes acquired knowledge. It is the same with all the faculties of the mind; they cannot be developed until the conditions necessary for their existence are fulfilled."

Either Rudolphi has not read my answer, vol. II, p. 228, &c., or, he lives only in his vast erudition, which prevents him from perceiving the force of my arguments; therefore, I refer both him and my readers to them. Now he adds, that in the brain one faculty is developed after another; for instance, memory the first, without any division of the cerebral organs taking place. If I consult the laws of my thinking principle, I reason thus; since in the brain one fac-

ulty is developed after another ; since one can be developed before or after another, I conclude from this, that one part of the brain belongs to a different function from that, to which another belongs ; that consequently the brain is an aggregate of many organs. I have however thought, that I could perceive, that Rudolphi finds himself a little embarrassed, since he retires behind the action of the mind (*Geistiges Wirken*), and refers his reader to his psychology (*Seelen Leben*.) An excellent method of conciliating the minds of the spiritualist ! In the mean time, the mind appears to me to be less a spiritualist, than the spiritualists themselves ; it knows that, in early infancy, the brain is not yet sufficiently developed ; and on this account it remains in absolute inaction. In proportion as the different cerebral parts are developed, it is partially produced upon the scene ; it plays its entire part as soon as the brain is entirely developed ; then, in proportion as this last is enfeebled, it is more retiring, and, when the period of decrepitude arrives, it leaves the stage entirely ; when the brain is in inaction, so in sleep, fainting, the mind reposes also : when there is a very great or very little development, either of the whole brain, or of particular parts of it, it is either entirely or partially embarrassed or imbecile ; when the brain is affected by intoxication or inflammation, the mind manifests its disordered state by delirium and insanity ; this is the independent spiritual action of the mind !

Sixth proof of the plurality of organs : a long continued action of the mind does not equally fatigue all the intellectual faculties ; the principal weariness is partial, so that we can continue our occupations, provided we change the subject in which we are engaged. This would be impossible if, in any occupation of the mind whatever, the whole brain was equally active.

Here again Rudolphi reproduces the same objection, to which I have replied in the second volume, pages 438 and 443. He is either ignorant of any

answer, or he intentionally leaves his readers ignorant of it. "The same thing," adds he, "happens for all the other organs, of which every one admits the *unity*. The same exertion fatigues, and change of action revives, until finally total repose becomes necessary. We can also pass from a severe mental exertion to one of less intensity, and finally, to absolute repose. This rest would not be necessary, if every time other organs were in activity. Our *moi* knows very well, that it is constantly in action, and a repose, which is not brought about by fatigue, brings ennui; in what cerebral part must we seek this on the hypothesis of Gall?"

On the hypothesis of Rudolphi, how can you conceive of the fatigue of the independent *moi*, the ennui of a *moi* essentially and constantly active? Multiply, gentlemen professors, more and more the occult powers; personify life, vital power, the *moi*, &c.; deprive us of these miserable material organs, the nerves and the brain; then will the physiology of the brain become simple?

And these organs, the unity of which no one denies, where are they? Is it the eye, is it the organ of hearing? Let us hear a very learned professor of the university of Berlin, M. Rudolphi; in speaking of taste, page 283, he thus expresses himself, and with great truth; "the tongue tastes on its whole surface, and particularly on its edges; yet at its tip the savor of the same substances is not the same, as on its anterior and posterior parts, as many authors have already observed. Certain kinds of savor are more developed, either on the anterior or posterior part of the tongue." And he derives this difference of taste from the difference of the nervous papillæ. Is it thus then that Rudolphi demonstrates the *unity* of the other organs!

Finally, I have spoken of the origin of certain mental diseases, and of the method of their cure; I have referred to monomania, or partial mental diseases, and I have taken them as two new proofs of the plu-

rality of the cerebral organs, in giving to the explanation of these phenomena a great physiological and pathological development. Vol. II. p. 443, 450, &c.

Rudolphi says, on the contrary: "No one will be of the opinion of Gall. By a singular incoherency, he takes for example the organ of music; is the musician perfect in every thing," says he? "is there not perhaps wanting in him delicacy, a taste for the simple, for the sublime, in his lessons? All musicians accuse each other of having false ideas in their art. Does not one stomach digest meats very well, and another very ill? Where is the man that does not deceive himself, even in the objects of his studies? Does not this happen to Gall in his work; does not the same thing happen to the author of this physiology? If all the different fixed ideas required a particular organ, there would be millions; but, slight modifications of the same parts suffice for their production."

If Rudolphi had read, or if he had had the courage to inform his readers of my answer to these same objections, vol. II. p. 462, 498, vol. II. p. 428, 449, quarto edition, he would certainly have dispensed with this unconnected raving, altogether unworthy of him. It is the duty of an author, especially if he is a professor, to acquaint his pupils with the true opinions of those whom he pretends to refute, the motives or the proofs of these opinions, and the answers given to objections made by adversaries. But Rudolphi, like all my antagonists, has not fulfilled this obligation; and this conduct will always be the signal of the triumph of the physiology of the brain.

Let us now see what are the ideas of Rudolphi on the functions or the value of the brain:

"Let us suppose," says he, "what however I do not admit, that the brain is provided with particular organs for its special operations; we are compelled to admit, that we are not acquainted with any. All that we can with assurance admit is, that certain cerebral parts are in immediate connexion with the external

senses ; but this cannot be demonstrated for the organ of visions, but with the optic thalami, corpora geniculata, and in part with the anterior pair of the corpora quadrigemina, and, as it respects the olfactory nerve, the bulb of this nerve, and the anterior lobes of the brain. It is not now certain, whether the sides of the fourth ventricle are the central organ of the auditory nerve. Then we know, that lesions of the superior region of the brain (in going from the corpora striata) cause a paralysis of the opposite side ; that lesions of the annular protuberance destroy the equilibrium between the anterior and posterior half of the brain. On the contrary, nothing is known of the organs of Gall. It is true, Gall believes, that he has discovered a great number, and that he has many times perfectly demonstrated them. But the source of his pretended knowledge is an untenable cranioscopy. He believes that he can find the same form of head in men, who are distinguished by a common quality or faculty ; for example, the talent for music, memory of words, &c. ; and, when a part of the cranium is protuberant, he believes that the cerebral part, situated behind this protuberance is greatly developed, and that the talent in question depends on this part. *Vice versâ*, he pretends, that this protuberance does not exist, when the talent is wanting ; on this account he was obliged to place all the organs on the surface of the brain. The facts, favorable to his hypothesis, were placed in a strong light, while those contrary to it were kept out of sight, which proves the nullity of the whole of his system. When, for example, any one had a portion of his cranium, which denotes a certain talent strongly developed, without the actual possession of it, the answer is, that the disposition to this talent is very strong, but the talent has not been developed ; yet this great disposition ought necessarily to have effected the development of the talent. So also, when in any one who possesses a talent to an extraordinary degree, the part of the cranium, corresponding to this

talent not being prominent, he escapes behind this miserable subterfuge, that the disposition is in reality feeble, but that education or application has occasioned the great development of the talent."

Rudolphi and Ackermann, since they impute to me this method of procedure, probably find it very convenient. A large number of those, who only know my discoveries by report, in their ignorance of better means, imagine that things go on in this way. I invite then Rudolphi to read, in my works, first the preface, the introduction, the exposition of the means that I have constantly employed, to discover the fundamental powers and the seat of their organs; my discourse on the difficulties of making these discoveries; my treatise on the influence of the brain, on the cranium in different ages, in health and disease; the history of the discovery of each faculty and the seat of its organ; finally, the particular treatises on each fundamental power, with the numerous proofs derived from man and a multitude of animals, and he will be astonished, if not at the uncandid manner, at least for the imprudent levity, with which he presents my works to his readers and auditors.

Every line of what he pretends to know of the anatomy and physiology of the brain, reveals his profound ignorance, and the most ridiculous pretension, that no one knows that, of which he is ignorant.

"I have had occasion," continues Rudolphi, "to examine many hundreds of brains; but I have never found any thing which was in accordance with the theory of Gall. Almost always I have found congestions; very often, an effusion of water, of a plastic lymph, of blood; very often, inflammation of the membranes; very rarely, inflammation of the cerebral substance itself; softenings of a greater or less extent, but always irregular; very often, indurations (principally in scrofulous individuals); once, an induration of the whole annular protuberance; sometimes, other tumors," &c.

Happily, the authority of Rudolphi is not of the first order. There are so many very true and positive anatomical facts, that he has not seen, or that he has wrongly seen! For instance, he has not seen the series of prominences in the spinal marrow; the true decussation or interlacing of the pyramids; he has not seen the natural unfolding of the hemispheres in hydrocephalic subjects; he has not properly observed the organization of the cerebellum and the annular protuberance, the formation of the great commissure of the hemispheres; he has not been able to see the artificial unfolding of the brain and cerebellum, the origin of the optic nerve; the relations of the brain itself, with the different brains of the different species of animals, &c. &c. In general, Rudolphi sees very little by himself; he adopts or denies by his learning. I will wager, that, at this very moment, he does not perceive that, as a general rule, the cerebellum is much smaller in proportion to the brain before the age of puberty, than in the adult period; that, in old age, the cavity of the cranium becomes more narrow, and that the convolutions of the brain are more flaccid and soft; that, in woman, the posterior lobes generally extend farther beyond the cerebellum, than in man, &c. &c.

How many things could I cite, that anatomists and physiologists did not see, a few years since, which all men, versed in new discoveries, see now? In order to see, we must have complete and exact ideas, we must have principles derived from the organization itself, and, finally, we must have learned to see.

Rudolphi reproaches me with having made changes in the organs. If I had written earlier, certainly I should have made many more. I have never wished to be talked about; from this very day, whoever will convince me of the falsity of all my discoveries, I will be the first to announce it to the public. Truth is my object. I place that above all personal and exterior considerations. May all my adversaries follow my example!

This professor also attempts to invalidate the stability of my fundamental qualities and faculties, and the seat of their organs, because M. Spurzheim has introduced some modifications into the physiology of the brain. I have already replied to this idea of M. Jourdan; if such an argument was of any weight, what would become of all the objections of my antagonists? There is not one, that has not been contradicted, undervalued, or refuted by one or the other of them. In their view, it is only their own arguments that have great weight.

Finally, Rudolphi enumerates the fundamental powers, as I have established them. He says that I accord vices and virtues to animals. Vice and virtue suppose moral motives, of which the most noble animals have, perhaps, but a very obscure notion. But Rudolphi (in his zeal for the rights of man) has confounded good and bad qualities with vice and virtue.

To prove the nullity of all these discoveries, Rudolphi undertakes to refute the existence of the organ of the propensity for propagation. Among my proofs he cites, that the cerebellum is greater, when this propensity is the most imperious, and during the rutting season of animals, and smaller, on the contrary, in those that are castrated and mules; that in those addicted to onanism, the cerebellum diminishes and becomes painful; that the propensity to propagation loses its energy after lesions of the cerebellum. The reader, who may desire to refer again to my treatise on the propensity to propagation, will see that Rudolphi has hardly glanced at my arguments. But this is of no consequence, for, in conformity with his expeditious habit, he opposes me, 1st. in maintaining that the cerebellum is smaller in animals than in man, without there existing in them less energy of the propensity for copulation. How powerful, says he, is this propensity in birds, in whom the brain is so small, compared with that of mammalia, and especially in comparison with that of man?

Rudolphi has, then, entirely forgotten what I said, vol. II. p. 280, octavo edition, and vol. II. p. 318, quarto edition, on the absolute size of the brain and its parts, compared with their functions. From the ideas of this professor, it would be difficult to conceive how ants, bees, &c., can have the instincts of propagation, love of young, construction, self-defence, laying up provisions, &c. He confounds the brain of birds with their cerebellum, and he does not remember that birds, like most mammalia, have but a single season for their loves, whilst man is influenced by this propensity both in winter and summer, autumn and spring, often from before the age of puberty, even to old age.

"2d. All trace of cerebellum disappears in moluscous animals and worms, &c., and also in those, lower in the series of beings, and yet we see them all influenced by this propensity."

So long as there exists a cerebellum in any animal whatever, there is a multiplication of their species by copulation, or an analogous act. When the cerebellum no longer exists, no longer is there any connexion between the sexes; let Rudolphi demonstrate to me the contrary of this.

"3d. If we consider the large development of the cerebellum in man, we cannot refuse to admit, that this part possesses a great proportion of the perfection of the organ of the mind."

The perfection of the organ of the mind depends on the perfection of the brain and its particular or specific action, and this same brain is not only the agent of the superior faculties of the mind, but it is also of the sentiments and propensities; the first, the most imperious, the most indispensable of these propensities, belongs to the cerebellum.

"4th. Cretins, in whom the cerebellum is small, are more or less imbecile, whilst the venereal propensity is often exalted to erotic mania."

Again, Rudolphi does not in the least regard what

I have said, vol. III. p. 333, octavo edition, and vol. III. p. 131, quarto edition, on the activity or inaction of the instinct of propagation in idiotism. He would have seen, among other things, that in salacious cretins the cerebellum has always a very great development; that, on the contrary, in those cretins that have no propensity of the kind, the cerebellum is very small. Thus, Rudolphi decides upon a question, that he has never examined in different cretins themselves.

"5th. Lesions of the posterior parts of the head easily bring about a want of memory," &c.

What memory? And lesions of the posterior parts of the head, are they lesions of the cerebellum? Rudolphi has probably read, that a certain pedagogue placed memory in the posterior part of the head. We have always erudition without personal examination.

"6th. It is not the cerebellum, but the spinal marrow, which suffers immediately by the abuse of physical love. Hence, there results dorsal consumption, with paralysis of the lower extremities."

In these cases, can we presume that Rudolphi has examined both the cerebellum and spinal marrow, when he tells us that there is only atrophy of this last, and, not of the cerebellum?

"7th. That which Gall advances concerning the increase of size of the cerebellum, during the rutting season, has never been demonstrated by experience; but he has confounded the swelling of the neck and nape with the size of the cerebellum."

I am very far from denying, that Rudolphi has never observed this increased nervous turgescence of the cerebellum, during the rutting season, or during the loves of animals. For this, it would have required a considerable collection of heads and brains of animals, killed in the moment of heat, to compare them with as many brains of animals, destroyed in the opposite season. It would be difficult for so learned a man, to have recourse to so laborious a source of true knowledge.

Finally, Rudolphi continues, that consequently I am deceived, as to the function of the cerebellum, as of the other parts. In the mean time, he has found it convenient to make no mention of the history of this discovery, of observations already made previously to mine, by Hippocrates, Apollonius of Rhodes, Van Der Haar, Tissot, &c. He says nothing of successive manifestation, increase and decrease of the instinct of propagation, always in direct relation with the development and decrease of the cerebellum in the different ages; of the very energetic activity of the instinct of propagation, in the period even of infancy, when the cerebellum has acquired an excessive premature development, whether the sexual parts are developed or not. He never has attempted any verification, nor spoken of our experiments made on men and animals, respecting the degree of their instinct for physical love. Has he compared the cerebellum, or the external sign of extremely amorous individuals, with others, who have no idea of the difference of sexes? Has he examined individuals, who were powerfully excited to the commission of certain vices, that are punishable with death in England? Has he made similar researches among animals extremely amorous, in comparison with other individuals of the same species, but quite indifferent in respect to this act? Has he compared the cerebellum of males with that of females, as it regards the different degree of the propensity to propagation; for instance, the dog and the bitch, the bull and cow, the stallion and mare? Has he compared the cerebellum of man with that of woman? Has he ever given any attention to the kind of caresses, which many animals make to excite the venereal act? Has he ever made any observations on the influence of castration, whether entire, partial, or unilateral, on the cerebellum? As a physician and physiologist, has he observed the influence of the lesion and the diseases of the sexual parts on the cerebellum, and the lesion and diseases of the cerebel-

lum, on the sexual parts? Does he know the cause of erotic mania? What does he think of those cases, where the instinct of propagation survives the destruction of the genital parts, and exists in the absence of these parts? Does he know the nature of apoplexies, so frequent after or during a very ardent act of copulation? These are so many questions, resolved in my treatise on this instinct and its organ, but which weary the patience of the antagonists of the physiology of the brain.

In treating of the functions of the external senses, Rudolphi cannot conceive, page 284, how I can attribute to animals an organ of taste of greater extent, than belongs to man. He maintains, that most animals have no taste, and that the very few of those who do taste, have the faculty very imperfectly; according to him, we find nothing remarkable in the cavity of their mouth, and in those that swallow their food whole, there certainly can be no taste. Animals do not taste in chewing and swallowing their food; it is only in ruminating, that they perceive savory substances; formerly, it was the sense of smell that directed them; thus, says he, birds of prey swallow little animals without tearing them; the échâsses and palmipèdes, the insectivorous and graminivorous animals swallow frogs, insects, and grains, whole; there are but a very few animals, that enjoy the sense of taste to such a degree as the parrot.

As my treatise, on the functions of the external senses, is not in this edition of my works, I will copy from the large edition, the following passage, which served as an answer to an objection of professor Ackermann, and which affords us the extent of the opinion of Rudolphi.

Professor Ackermann, causing the perfection of the intellectual faculties of man to be derived from the delicacy of his senses, maintains, that the nerve of taste is proportionally larger in man, than in animals; that in him, it is spread out on a softer and more mov-

able tongue, the nervous papillæ of which are covered with a much finer epidermis than in animals. But, proportionally, the gustatory nerve and all the fifth pair are very distinctly greater in animals, than man. The nervous papillæ in multiplied forms, disseminated in the pharynx, the palate, on the whole tongue, the internal surfaces of the cheeks and the lips, are much larger and more numerous than in animals. In order to make the surface of the organ of taste more extensive, the palate, in many animals, is covered with a membrane, grooved and studded with numerous nervous papillæ; and, in general, the apparatus, which serves for the action of eating, is more extensive in them than in man. In the dog, bear, monkeys, the epidermis of the tongue is as fine, as that of the tongue in man; if this organ in us is more movable than that of animals, this property is only connected with the faculty of speech, and has nothing to do with taste. Besides, if we reflect that, in the action of eating, the organs of animals procure for them the most intimate and enduring pleasure; that a great number of them, when they are awake, spend nearly all their time in eating or ruminating; it will be difficult not to admit, in animals, a more perfect and extended taste. Consequently, whoever shall be disposed to expect, from a better organization of taste, intellectual faculties, in some respects more perfect, ought at least to let us know, what are the alimentary preparations invented by the dog or ox.

We cannot admit the general opinion, that birds have an obtuse taste; at least, it seems to us impossible, that all are in this condition. Blumenbach has found the organ of taste in the duck, comparatively much larger than in the goose; so also we observe that the palate of many birds, such as birds of prey, heath-cock, &c., is garnished with nervous papillæ, very numerous and strong. A great number of birds do not swallow their food at once; the tom-tits, for instance, in a manner lick it; most birds, that live on

insects and grains, crush and bruise them; what reason should we have in this case, to attribute to them a less perfect taste than other animals? Let any one give to the canary bird, bullfinch, nightingale, or cuckoo, many different kinds of food, each will select without fail, that which he likes best; the canary prefers dog-grass; if we give to nightingales, that are newly caught, the larvæ of ants, a great number will die of hunger, because they do not know the kind of food; if we put them in their beak, they usually reject them; but if we crush them, they swallow them with avidity. This evidently proves, that they have a very delicate taste.

Birds even that swallow their food at once, such as hens, pigeons, &c., distinguish berries and grains by touching them with the end of their beak. Let any one mix the grains of vetch with those of the *robinia caragana*, the *cytissus* of the Alps, &c., the hens and pigeons will take them all without distinction, but they will soon reject the two last. Thus the horny extremity of the tongue does not exclude taste; it seems on the contrary to be a prolongation of the lingual nerve, destined to give this part a more delicate taste. If storks have been accustomed to receive in their beak rats and frogs, that are thrown to them, they swallow them with avidity, after having tossed them many times in the air, recaptured, and crushed them; but if we throw them a toad, they instantly reject him; they greedily swallow large flies and bees, but, if they catch an insect that they do not like, they reject him. Swallows and all birds, that live on insects, do the same.

It is an error, then, to suppose that a humid solution is first necessary to cause the sensation of taste. The surface of grains and insects, certainly excites on the tongue oleaginous, alkaline, spirituous impressions, that the taste instantly perceives, by means of instruments organized for this purpose. Vol. i. p. 152, quarto edition.

Add to this, that the dog, when hungry, swallows without chewing, greedily chews filberts, almonds, chestnuts; that he laps milk with great delight; that, like almost all other animals, he loves sugar; that the hog and duck, who root and dabble in the mud, tear and chew roots, insects, frogs, &c.; roebucks and pigeons, who greedily seek dirty slime; is it possible to deny an exquisite taste to all these animals? It is then much less conceivable, how Rudolphi can maintain, that the sense of taste is wanting in most animals.

§ 315, Rudolphi makes the greater part of the optic nerve, to arise in the so called optic thalami. "I have had occasion," says he, "to dissect the brain of an infant, in whom the right eye and orbit were wanting, while the left eye was well organized. The corpora quadrigemina were of the same size on both sides, but the left optic thalamus alone maintained its natural position and size; the right optic thalamus formed at its inferior part a projection, from which arose a kind of appendix, a sort of rudiment of the optic nerve, which was wanting, and which was again lost in the brain. This case evidently proves, that the optic nerves do not at all derive their origin from the tuberculæ quadrigeminæ, although I do not protest, that some connexion exists between the corpora geniculata and the anterior pair of the tuberculæ quadrigeminæ for the origin of the optic nerve."

Has Rudolphi examined the proportions of the two hemispheres in the case cited? He is certain, that, if there was a diminution of substance in the right optic thalamus, the right hemisphere ought equally to be diminished. Quite often we have met with brains, particularly in insane hospitals, where one hemisphere was smaller than the other, and this diminution always coincided with a diminution of the corresponding thalamus. We have not observed in any of these brains, a diminution or atrophy of the optic nerve, unless there was also a diminution in one side of the

tubercula quadrigemina. Besides, the optic nerve certainly does not derive the whole of its origin from the tubercles; the internal and external corpora geniculata, &c., furnish it with a large number of nervous fibrillæ. It is on this account, that the optic nerve is not in proportion to the size of the tubercles, which, as in the mole, may be very large, with an extremely delicate optic nerve. But, what does this confused language mean; *the optic nerve certainly does not derive its origin from the tubercles, and some connexion exists between the corpora geniculata, and the anterior pair of the corpora quadrigemina for the origin of the optic nerve?* I still oppose to the assertion of Rudolphi, that Sæmmering, Spurzheim, myself, and many others, have always seen a diminution of one side of the tubercles, when there was an atrophy in one of the optic nerves. There is not then a doubt, that, in this observation, the professor has not seen rightly.

In my large work, I have maintained that man, as well as animals, distinctly mark objects but with one eye. I have distinguished between the passive and active function of the senses. The two eyes see passively; but every individual fixes the object with one eye only. Rudolphi pretends, § 320, that it is easy to refute me. I believe, that it is still much easier to have the assent of every reader. No one doubts, that we see with both eyes at once; since, with the exception of a very few observers, every one confounds passive with active vision. Not to hold the reader in suspense, I shall be pardoned, if I copy from my large work, the passage relating to this subject, vol. i. p. 189, quarto edition.

We cannot conceive how, even to this day, so little attention has been given to this general fact: that all the operations of animal life, and, consequently, those of the senses, are, in certain circumstances, purely passive, and in others, purely active. In waking and sleeping, it is not possible for us to perceive or not

perceive the impressions of objects on our senses. We feel, taste, hear, see, touch, without the action of our will. In this respect, the senses are passive. It is quite different from this, when we direct our attention positively to the impressions of the senses. In smelling, tasting, hearing, seeing, feeling, our own internal activity acts upon the objects.

The double organs of the senses always contribute to cause us to receive the impressions passively, and to excite in the brain a sentiment, more or less obscure or distinct, of these impressions. We hear with two ears, and see with two eyes, when sound and light impinge upon these parts, without our express participation; but, so soon as we react actively on these objects, one only of the two organs acts. We hear attentively but with one ear; we accurately observe an object but with one eye.

We foresee, that this assertion will seem erroneous to most of our readers; and as, in our public lectures, we have always proposed to explain, in some sort, the reason why we see single with two eyes, it has frequently been opposed by our adversaries. To say that one single organ is active, while the other is at rest, is, according to Ackermann, to use a pitiful subterfuge. This professor believes, in relating an experiment which we shall cite, that he has demonstrated incontestably, that we observe objects fixedly with both eyes. Such also is the opinion of Autenrieth, and there is only a very small number of physiologists, who have been able to seize the idea, that we only see steadfastly with one eye.

Let us offer to our readers the facts, on which this assertion rests. One of us (Gall) in his youth, was fond of playing with a long tube slightly curved, through which he blew peas; he could always very accurately hit the objects aimed at; he frequently, on the contrary, failed when he used a tube perfectly straight; he could not account for this difference, until, finally, he placed the straight tube in a direct line

from his mouth to the object. Then he observed the instrument with one eye, and saw that it was directed obliquely towards the object. In connecting this fact with the circumstance, that, when firing a musket, we are obliged to place one eye in a straight line with the point of aim, he concluded, that we could not aim accurately with both eyes. Afterwards, he tried to trace a straight line in a garden, with vine props; he placed his nose upon the first, and always fixed the rest, the one exactly behind the other; but when he observed his line at the opposite extremity, he saw that the props constantly separated from each other, he could not obtain a straight line, until he placed his right eye alone upon the first prop. If we in reality aimed with both eyes, we ought, in both cases, to obtain a right line by starting from the middle of the face. He believed also, that he could explain, why the paths always proceed in a serpentine direction in snow and fields. Let any person hold a small stick, a knotting needle, a quill, or other similar body between the eyes and a candle, in order to find a straight line between himself, the stick, and candle; the shadow of the stick, if held directly opposite the candle, should necessarily fall upon the nose, when the aim is taken with both eyes open. But every time the shadow falls on a single eye, namely, on that which we are accustomed to use, when we fixedly regard an object. If this eye is closed, while the candle and stick remain in the same position, we observe that the first object is considerably separated from the straight line; if, on the contrary, the other eye is closed, the position of the stick and candle appears in the same direction. This proof contradicts that of Buffon, which we have before related, and from which he would infer, that we see every object double; but it proves most evidently, that we look fixedly but with one eye. Request any one to look attentively at a small object, at the distance of one or two feet, both the eyes appear to be equally directed

towards the object. Shut or cover one of the eyes, the other will not move at all, if it is the one with which the person is in the habit of looking accurately, but if this last is covered, the other immediately turns slightly inwards, which enables it to fix itself upon the point of observation; let then the closed eye be opened again, the other then involuntarily and unconsciously turns outwardly to the same extent, that it had previously moved inwards. This experiment proves then, that the two eyes are not equally fixed on the same object, and cannot look upon it at the same time. Even in squinting, when the object appears double, we can fix our sight but upon one of the images and with one eye; the second image is only seen passively. Animals, whose eyes are placed at the side of the head, can only look with one eye; Cuvier has also remarked this, and has concluded, that the same observation can be applied to man. In reality, man, for instance the painter, and animals that have their eyes in the front of the head, such as the dog, monkey, &c., evidently prove by their gestures and the motion of the head, sometimes on one side and sometimes on the other, that they see an object, sometimes with one eye, and sometimes with the other.

Lecat, whose excellent work would merit a revision, is the only writer, where we have found our opinion nearly expressed. "If it could so happen," says he, "that the mind should leave one of its eyes vacant, that it should use but one eye at a time, or that it should only attend to one of two images, the difficulty would be soon obviated, and it is true, that the mind generally does so. We look at an object attentively, but with the eye of that side next the object; and the other is, as it were, at rest, until its turn of activity comes to take the place of the former. I have even observed, that there are certain days, when it is almost always the turn of one eye to see objects, and I have reason to suspect, that this happens, because this eye on these days has greater vigor than the other. I am

convinced, that in many people, there is always one eye stronger or more watchful than the other, and which constantly takes charge of the greatest part of the common task." Lecat, however, believes, that this kind of one-eyed vision is not universal, and he undertakes to prove, that we also see at the same time with both eyes. But, in all the experiments which have been undertaken to attain this object, he constantly confounds passive with active vision, as do also our adversaries in the objections, they urge against us.

Professor Walter of Berlin, Ackermann, and their partisans have opposed to us the following experiment to prove, that we look fixedly with both eyes. If we observe a luminous body, such as a candle, with each eye armed with a glass of a different color, the eye which looks through a red glass will see the object red, and the one armed with a blue glass will see the object blue. But the two eyes together will neither see the object red nor blue, but green, which is a compound of these two colors.

This experiment has been imagined, believed, and copied in theory, from an erroneous supposition, but has never been confirmed in practice. We have often repeated it, and caused it to be repeated by others. If the two glasses are equally thick and transparent, we see either red or blue, as we have been accustomed to look fixedly with one or the other eye. But if one glass is thinner or more transparent than the other, its color alone gives the color to the object. Never have we been able to see the green color. It is true, that we see green when we look at fields and trees of this color, because the colored glasses do not entirely extinguish the green color. At the first instant we often perceive rays of a mixed color; but we should attribute this to the impression, which still remains in the eye, before which another glass has been held. It is in this way, that we often see spots

of a different color, when we carry our eyes from one object to another of a different color.

Consequently, in continuing to fix our attention on the difference between passive and active vision, it will be difficult to prove, that we can attentively observe an object otherwise than with one eye.

§ 323, M. Rudolphi comes to psychology (*Seelen Leben*) and passes rapidly over the following questions: Whether animals, monsters, and idiots have a soul; if the pieces, into which we can divide certain living beings, have each a soul; which, according to him would be incompatible with the unity of the individual, the *moi*. In opposition to Bichat he admits, that the affections have not their seat in the viscera, but solely in the brain.

He establishes three distinct manifestations of the mind: intelligence, sensation, and the appetitive faculty. The powers are not always manifested in the same manner, but are in different proportions, not only in different individuals, but also in each particular individual; he does not admit the existence of innate ideas, but, with me, innate dispositions, by means of which we arrive at abstract ideas.

After having explained his ideas of memory, judgment, imagination, the affections, passions, and having considered them according to the routine of the philosophy in vogue, he refutes physiognomy, with which he confounds pathognomy.

He terminates this paragraph by giving a mortal thrust to craniology. "Craniology," says he, "has the cranium alone for the object of its researches; it pretends to be able to know, by this, the brain, and of course the character and dispositions of men; which is absolutely false. Besides, it never despises the assistance of its elder sister, physiognomy, in creating at the same time a kind of imitation, which it merely places more in connexion with the cranium.

"Craniology has had little success, and it deserves no more confidence than chiromancy."

My readers know how to understand this, so far as craniology is concerned; it is indeed very pleasant to observe the obstinacy of most of my adversaries, in wishing to reduce all my discoveries on the anatomy and physiology of the brain, to simple craniology; they demonstrate by this, either their bad faith, or their complete ignorance of the true end of my labors. In denying the utility of craniology, they not only deny the plurality of the cerebral organs, the different development of these same organs, and consequently the different forms of the brains and heads, but also all influence of the brain on the form of the head, all possibility of arriving at the knowledge of the seat of the organs. And do you know why they say, that the craniologists do not despise physiognomy? Because, that in visiting, in our travels, prisons, hospitals for the insane, &c., many professors, pupils, ministers of state, have witnessed how frequently we have determined, with the utmost precision, the nature of the crimes or the insanity and the predominating propensities and faculties, of the prisoners and the insane. In order to escape the necessity of rendering this homage to craniology, they bestow all the merit on physiognomy. But, as they neither believe in the one nor the other, how can they explain these facts?

Yes, I have created an art of imitation founded on unshaken principles, the only one which reveals to us the mystery, the source of pathognomy, the gestures and the attitudes, that our thoughts, sentiments, propensities, internal emotions produce in us externally. Read my treatise on this principle of imitation, and you will be convinced, that each gesture that accompanies the strong action of an organ, is a proof of its seat, and consequently of the plurality of organs. But, here especially, something more is requisite than knowledge.

Let us suppose, then, that craniology, or rather the physiology of the brain, has not amounted to much, organology should have taught me not to ex-

pect much of it. Exclusive ideas, extravagancies, superstitions, futilities, fashions, make fortunes. The transcendental philosophy, metaphysics, ideology, animal magnetism, brunonianism, &c., &c., have also made fortunes. To oppose received habits, to brave the decisions of academies, to humiliate self-love, to overturn the pretended knowledge of the anatomy and physiology of the nervous system, to destroy the systems of philosophy of three thousand years, &c., how can it be expected, that one should succeed with such elements? Where is the child, that does not suffer from being weaned, even when more substantial food is given him?

Let craniotomy, according to Rudolphi, merit no more confidence than chiromancy, this is perfectly well explained; first, he rather adopts the conclusions of others, than thinks or examines, for himself. Either M. Carus, or M. Jourdan has said so. What more is wanting?

In the second place, Rudolphi has not the slightest knowledge of the discoveries relating to the anatomy and physiology of the brain; he has not the least idea of the mechanical aptitudes, instincts, propensities, and faculties of animals, nor the fundamental moral qualities and intellectual faculties, or the philosophy of man; the comparative anatomy and physiology of the brain of man and animals, are nonentities for him. In conclusion, I refer Rudolphi to the answer which I have given to M. Jourdan, in this same volume.

Experiments on the Nervous System of Man and Animals, published in Italy in 1819,* and republished in France in 1822:† by COSTER, M. D., of the Faculty of Turin.

In the third volume, I have given my own reflections on the report of Baron Cuvier, concerning the experiments of M. Flourens. M. Coster, in a translation of the work of Rolando, has answered my observations. At that time, I was unacquainted with the dissertation of M. Rolando, and the memoir of M. Flourens. Since then, I have studied their works, and the frequent contradictions in the results, which each has arrived at from the same experiments, have tended to confirm my opinion, that mutilations are the worst methods of becoming acquainted with the nervous system. M. Coster has directed his attention, first to giving credit to his old professor for some new discoveries in the anatomy and physiology of the brain. He supposes that M. Cloquet, in his descriptive anatomy, has borrowed the description of the brain from Rolando. In order to secure to the latter the priority of these discoveries, he endeavours to establish the following fact: "the course of the medullary fibres, which expand to form the hemispheres of the cerebrum and cerebellum, as discovered by Rolando, does not differ essentially from the explanation, which Drs. Gall and Spurzheim have given of it." "It might be supposed," adds M. Rolando, "that I had had some acquaintance with the exact method of these ingenious anatomists."‡ "I may add, that I confided at the same time, to Professor Palloni, Secre-

* Saggio sopra la vera struttura del cervello del uomo e degl' animali, e sopra le funzioni del systema nervoso. Di Luigi Rolando, 1809.

† *Archives générales de Médecine*, tome 1er., mars 1823.

‡ Memoria sulle cause da cui dipende la vita degli esseri organizzati (Firenze, 1807).

tary of the Italian Academy, a memoir, containing the explanation of the functions of the nervous system, in all living beings, founded on their organization and on some experiments, which demonstrate the use of the different parts of the cerebral mass. Further, in my instructions in the theory and practice of medicine, I have not only, for some time, classified the diseases of the nervous system into affections of the hemispheres, of the cerebellum, of the medulla oblongata, and of the sympathetic nerve; but I have also shown, with the constant support of experiments and observations, that there is not one symptom, nor a single phenomenon, which does not meet with a ready explanation; while, in the best treatises on these diseases, all is disorder, obscurity, and confusion."

"It seems to me, that one would have no difficulty in concluding from all this, that I was acquainted with the structure of the brain, such as I have described it, long before the physicians of Vienna had published their anatomical observations; since, by the aid of this structure, I explained the functions of the encephalon before that period, as well as those morbid alterations, most difficult to understand."* "I am far," continued M. Coster, "from wishing to insinuate, that Messrs. Gall and Spurzheim have profited by the anatomical researches of Rolando; on the contrary, I know that, at the time these celebrated anatomists published their first works, they could have had no knowledge of the work of which we treat. It is not the first time, that men of genius have, unpremeditatedly, coincided in the same point of doctrine."

If M. Rolando is sure of being able to explain, with the assistance of his discovery of the structure of the brain, the functions of this noble organ, he is certainly the happiest of mortals. But to leave here this nonsense, let us see, with what propriety he has argued his cause for the priority of his pretended discoveries.

* Saggio sulla vera struttura, &c., p. 89.

In the year 1807, he announced a new theory of the brain, entirely different from that, which, till that time, had been adopted by the most celebrated anatomists. The first volume of my large work, which contains the anatomy of the nervous system, together with that of the cerebrum and cerebellum, did not appear until 1809; but, for several years before my travels, I had constantly demonstrated the brain, according to my discoveries, to a great number of spectators, of all nations. I left Vienna on the fifth of March, 1805; and, immediately after, and during the whole of that year, and the years 1806-7, we made the same demonstration in presence of professors, pupils, and a great number of distinguished personages at Berlin, Halle, Leipzig, Jena, Dresden, Gottingen, Copenhagen, Leyden, Amsterdam, Heidelberg, Stuttgart, Carlsruhe, Brunswick, Hamburg, Munich, Frankfurt, Zurich, Berne, Basle, Paris, &c. &c. During my travels, several of my hearers have published my course of lectures, not to mention all the journals which have given an account of it, as of an object of lively curiosity and general interest.

The works of Froriep, Bischoff, Ackermann, Walter, professor at Berlin; Walther, professor at Bonne; Blöde, Muller, Meyer of Naples, Démangeon, &c., all appeared before the year 1807. Some appeared in the same years in Italian, French, Danish, Swedish, Dutch, &c. On the fourteenth of May, 1808, we presented to the Institute of France, a memoir, containing our anatomical discoveries. The report of Messrs. Tenon, Sabatier, Portal, Pinel, and Cuvier, was sent every where; and M. Rolando was only acquainted with my anatomical and physiological doctrine, as an absurd opinion, refuted by Malacarne! I have been made to assert, that the brain was nothing more than a mass of cellular tissues. This trick came to my knowledge only by this passage of M. Rolando's.

A very evident proof, that M. Rolando has not appropriated my discoveries, is his exposition of the

structure of the brain. The course of the nervous fibres, which contribute to the formation of the hemispheres, is very coarsely displayed in his plates, though it had long before been much better drawn by Vieussens and Vicq-d'Azyr. He is guided by no physiological principle; such, for example, as the successive approach of animals to perfection; he acknowledges, that he has had but three brains at his disposal. He must have been very ill acquainted with this subject, to flatter himself with making discoveries without the means of multiplying, repeating, correcting, and confirming his researches. Hence arises his want of exactness in the description of the passage of the pyramids, through the pons Varolii, the thalami optici, and the corpora striata. According to him, the nervous fasciculi of the corpora striata, as in the opinion of his predecessors, contribute to the formation of the great commissure and its dependencies; thus, he did not observe the entirely different direction of the divergent and convergent fasciculi. He knew nothing farther of the corpora striata, than had always been known by every one; the external portion of them, which far exceeds what is seen in the ventricles, entirely escaped his observation. Like all anatomists before him, he makes the optic nerve arise from the thalamus opticus; and, like many anatomists before him, he makes the olfactory nerve arise from the anterior commissure; he had not even a doubt of the manner, in which this commissure is formed by the nervous fasciculi, which issue from within the anterior interior extremity of the middle lobes; how then could he doubt of the formation of the septum lucidum? Like every one else before us, he considers the eminences, from which the optic nerves arise in birds, as the same with the thalami optici, so called, in the mammifera. In like manner, he considers the simple enlargement of the medulla oblongata, as the pons Varolii. As he was acquainted with no law of the organization of the nervous system, he did not

observe that birds, reptiles, and fishes want this protuberance, which is nothing else than the union of the nervous fasciculi of the lateral lobes of the cerebellum; now, as these animals have no lateral lobes, they could not have this union of the nervous fasciculi. Thus he had not the slightest idea of the formation of this protuberance or commissure of the cerebellum, or its decussation with the longitudinal fasciculi of the pyramids. The entire structure of the cerebellum is a great mystery to M. Rolando. Altini at first imagined it a galvanic pile, with layers of grey substance, and layers of white substance, placed alternately upon each other; other anatomists, like Reil and Rolando, found this fiction very plausible, and adopted it. They did not know, that the cerebellum was organized according to the same law as the hemispheres; that, in cases of dropsy of the cerebellum, its folds develope themselves, like the convolutions of the hemispheres of the brain, and that instances are not wanting, in which this development might be made artificially.

Professor Rolando also denies, that the grey substance furnishes nervous filaments; but he admits, that it contributes to their nutrition. In general, his ideas on this subject are wavering; this same grey substance assists in the formation of the galvanic pile; otherwise, he adopts the opinion of Malacarne on the use of these laminæ, and makes them contribute to the perfection of intelligence. He knows no better than myself, how Malacarne counted the leaves of the cerebellum; and, although he has only examined three cerebella, he believes, nevertheless, that he has had an opportunity of confirming the observation of this philosopher; he has observed, that the cerebellum of an idiot was composed of only three hundred and twenty-four laminæ; that of an intelligent man, of seven hundred!

M. Rolando asserts, that the cerebellum in animals is larger than in man. He nowhere manifests the

slightest suspicion of the cause of the optic thalami, the corpora striata, the pons Varolii, &c. ; why it is smaller in animals, such as the horse and the bull, than in man ; or why, on the contrary, the tubercula quadrigemina, &c., the medulla oblongata, &c., are larger in animals than in man ; always a result of a want of physiological principles.

Lastly, M. Rolando, on the strength of having made such multiplied researches on the brains of man and animals, finds no other difference between them, than that of volume.

In order to spare his readers the details of the description of the brain, Rolando refers them to the works of Cuvier. M. Coster has, therefore, acted very prudently, in not being willing to specify the immense discoveries of his old professor, whom he has styled a modest professor, because he has not said, what he did not know. Thus, this pompous announcement of the new doctrine of the brain, entirely different from any which had been hitherto advanced by the most celebrated anatomists, reduces itself to this, that M. Rolando has not avoided a single received error, nor made the most inconsiderable discovery in the anatomy of the brain. I could never have credited this surprising result, had I not myself read M. Rolando's original work in Italian.

I at first prepared a work, to oppose the results of the experiments of M. Rolando, to those obtained from the same experiments by M. Flourens ; with the intention of proving, that mutilations of parts of the cerebrum can never become a method of obtaining an acquaintance with the different functions of those parts. But more recently, M. Flourens himself has come to the conclusion, that he ought to substitute some other method of experimenting, for that of Rolando, which may explain to him the reason of the difference in their results.

I shall, therefore, first oppose M. Flourens' reasons and my own, to Messrs. Rolando and Coster ; we will

next ascertain, whether the improved method of M. Flourens actually produces more constant, or more conclusive results.

M. Rolando is first at issue with M. Fontana: "I was long acquainted with the experiments of the celebrated Fontana, from which it appears, that a tortoise, whose brain had been removed, continued to live for six months, and walked as before. In vain have I repeated the same, experiment; every time that I have removed the brain behind the cerebellum, the animal died suddenly, in the same manner as one whose head had been removed.

"I had occasion to converse with M. Fontana, and asked him the reason of this difference in result. He assured me, that he had always obtained the same results, even after having entirely emptied the cranium. I then repeated the same operation with the greatest care, and with very little loss of blood. Every time, that the medulla oblongata was deeply wounded, immediate death ensued; and, in the space of twenty-four or forty-eight hours, it was no longer possible for galvanism to excite the slightest sign of sensibility."

Let us hear Rolando's account of his own experiments: "I have made," says he, page 366, "innumerable experiments on kids, lambs, pigs, bucks, dogs, cats, and guinea-pigs, to observe the results of injuries to the tubercula quadrigemina and the parts adjoining the thalami optici; *but have rarely obtained constant results*; which is not surprising, when we reflect on the intimate interlacing of the numerous medullary filaments, which are met with in these parts; for, as it is extremely difficult to ascertain what filaments have been divided in these operations, we cannot draw clear and precise conclusions, where there is some difference in the results." This is precisely the argument, I have always used against this kind of researches.

The following is the opinion of Flourens in relation

to Rolando: "To obtain determinate and constant results," says he, page 317, "I have always been obliged to isolate the different cerebral organs from each other, with the greatest care; to lay these organs open entirely, to be able to follow and guide the instrument with the eye, to remove them only in regular symmetrical layers, so as never to go beyond the limits, which unite or separate them. All these precautions were indispensable, in order to obtain them before they were known; now that we know them, the absence of a single one will be sufficient to prevent our reproducing them. We can here tell Rolando, that in operating as he always has, that is to say, without isolating or uncovering them, without seeing or knowing how far he goes or where he stops, he surely never will produce them."

"Rolando has then never observed other than complex phenomena; he never has deduced from them other than vague or contradictory consequences; he has constantly confined himself to the repetition of the experiments of Haller, Lorry, and Ziun." By and by, I shall examine once more, if this isolation of the cerebral parts is practicable. In the mean time, let us confront the experiments of Rolando and Flourens.

Experiments on the Brain of the Mammifera.

In the intention of observing what effects a current of galvanic fluid, directed from the brain to the different parts of the body, would produce, Rolando trephined the cranium of a hog; he then introduced into the hemispheres a conductor of a voltaic pile, taking care to touch sometimes one point, sometimes another, whilst the other thread was applied to the different parts of the body. Having repeated these experiments on different quadrupeds, he obtained only violent contractions, and noticed that they were

stronger when the metallic conductor penetrated the cerebellum.

M. Flourens, who does not believe, from his experiments, that the cerebral lobes, and the cerebellum, produce muscular contractions directly, presumes that the galvanic fluid is conducted to the immediate parts of contraction; that is to say, to the tubercles, the medulla oblongata, and medulla spinalis. Rolando believes, that the fibres of the hemispheres are destined to produce particular motions. M. Flourens says, that his experiments establish, that the hemispheres of the brain do not directly produce any motion.

The results obtained by Rolando were, that, whenever a large number of the fibres, which traverse the corpora striata, were cut or torn, the corpus callosum on the fornix were interested, a state of lethargy or stupor ensued; whenever the optic thalami were injured, sometimes tonic, sometimes clonic effects were produced, as catalepsy, convulsions. M. Flourens believes, that Rolando confounds here the effects of the lesion of the optic thalami, with those of the lesion of the tubercula quadrigemina, since, according to him, the lesion of the optic thalami does not produce convulsions. To the observation of Rolando; that the presence of food and a considerable noise do not induce the least motion in the kid, M. Flourens observes, that that is not astonishing, since, from his own experiments, the animal deprived of his cerebral lobes, neither hears, sees, nor smells, &c. Still, this same kid stands firm on his feet, and changes his position when seriously troubled. Can, according to M. Flourens, an animal still possess will, and sensation, without cerebral lobes? He again complains of Rolando, because he produces, sometimes stupor or lethargy, sometimes convulsions, according as he wounded at different times or all at once, the tubercula quadrigemina, the optic thalami, the corpus callosum, the fornix and its appendices. When Rolando, after having torn, sometimes the tubercula quadrigemina,

sometimes a portion of the optic thalami, attributes the irregularity of motion, or the apparent intoxication to the lesion of these parts, M. Flourens supposes, that the cerebellum has been wounded, without the knowledge of Rolando.

Experiments on the Brain of Birds.

Rolando removed two thirds of the cerebral lobes of a hen, without wounding either the medullary expansion, which is found on the internal face of the hemispheres, or the oblong portion, which is observed near their base. The animal appeared to suffer a little at the commencement of the experiment; but, after twenty minutes, began to walk, drink, and eat; she was, notwithstanding this, a little giddy and apparently intoxicated.

Flourens says, that from his experiments it constantly appears, that the animal does not feel lesions of the cerebral lobes; and he does not believe, that the intoxication can be attributed to the lesion of the cerebral lobes; it is, however, difficult to maintain, that in this experiment Rolando has wounded any other parts than the lobes, as Flourens presumes; for the cerebellum is considerably behind the cerebral lobes.

Rolando removed in the same manner a large quantity of the substance of the hemispheres; he tore, not only the above mentioned medullary expansion, but also that which is placed at the base of the hemispheres. In proportion as he wounded the hemispheres more deeply, the animal became stupid, and remained more calm. She was not then quiet here, any more than at the commencement of the experiment. Finally, she became sleepy, and lay down for some time; an hour afterwards, she rose up and continued motionless on her feet. Neither noise, food, water, nor punctures, could induce her to make the least motion.

Still, on smartly kicking her, she moved a little. They penetrated the optic thalami, in each of which they made three or four incisions, which produced no result, except that the eyes remained open, and the pupils dilated, without its being possible to close them by touching them with any foreign body. Without taking any food of her own accord, the hen swallowed some crumbs of bread, that were placed in her throat. Rolando performed this experiment on pullets, falcons, ducks, and almost always with the same success. Having involuntarily touched in a raven, on whom he had performed the same experiment, the point situated above the annular protuberance, the crow was seized with frequent fits of hiccoughing convulsions, and expired in half an hour. Having slightly touched the adjacent parts of the annular protuberance, in many pullets, hiccoughs were *twice* produced, (not *always* it seems,) but they were always followed by convulsions and death.

M. Flourens here makes the remark, as I have mentioned before, that Rolando takes the tubercula quadrigemina for the optic thalami; and, that he has never been in doubt with respect to the real functions of the cerebral lobes, since he has never observed the loss of vision, hearing, nor that of the intellectual faculties, as a consequence of their ablation. However, at a very loud noise, the raven opened his eyes; he heard, although M. Flourens avows, that the lesion of the hemispheres was deep, which explains to him the stupor and complete lethargy. In this same experiment on the hen, Rolando made three or four incisions in the tubercula quadrigemina, without producing any new results, except the same stupor, the same lethargy. Why does not M. Flourens point out this circumstance, so contrary to his experiments, from which the lesion of the tubercles ought to produce convulsions? M. Rolando again deceives himself, when, in birds, he speaks of the annular protuberance; for, birds not having the lobes of the cerebellum, neither have they the annular protuberance.

Experiments on the Brain of Reptiles and Fishes.

M. Rolando removed the two hemispheres of the brain from a very large sea tortoise. Having replaced her in the water, she swam for some time, then went to the bottom and remained quiet for some hours, turning only sometimes on one side, and sometimes on the other. When she was pulled up with the string, she swam a little, and then sank to the bottom.

He removed the two hemispheres of the brain from the squalus catulus, L., and having replaced him in the water, he rapidly swam away, and concealed himself behind a stone, where he remained motionless, unless he was irritated. These experiments were repeated in a thousand forms on tortoises, and the result was always the same.

How can M. Flourens conceive in this case of the determinations of the will,—the precipitate flight, even enough of intelligence remaining for the fish to conceal himself behind a stone, and the sensibility reëxcited by the irritation? for, according to him, the hemispheres are the seat of the will, intelligence, and voluntary motions.

Experiments on the Cerebellum in the Mammalia.

Let us first see the origin of the pretended discoveries in the function of the cerebellum.

"The structure of the cerebellum," says Rolando, "the important discoveries, made by the professor of Padua on the great number of laminæ of which it is composed, excited in me many suspicions of the true use of this organ. I believed that it was destined for locomotion." To confirm this opinion he undertook the following experiment on the cerebellum; he removed by repeated cuts all that he could, from one

of the sides of the cerebellum of a hog and a sheep. But hardly did the lesion extend beyond the trephined side, than the animal was seized with hemiplegia, and he soon died in convulsive spasms and hemorrhage.

"It is demonstrated," replies M. Flourens, "by my experiments, that the lesion of the cerebellum never produces convulsions; that, whenever these have been believed to have been produced by it, it has happened that the medulla oblongata has been wounded without its having been perceived." All this is very well to say; but will Rolando acknowledge, that his procedure has not been exact?

The form of the voltaic pile can at most create the idea, that the cerebellum may be destined to produce commotions, but by no means locomotion. May there not rather be here, in this, some influence of the ancient theory in vogue, before and after the time of Willis, that the cerebellum secretes the vital spirits, the nervous fluid, the action of which on the muscles should produce motion? For many years the German physiologists have called the cerebellum, the organ of locomotion (*Sinn der räumlichen Bewegung.*) However it may be, M. Rolando has always been anticipated, and here, as on other occasions, he has discovered, that which he knew, or which he *à priori* presumed, as for instance blindness, after the lesion of the optic couches in the mammalia, &c.

He cut, in different directions, the cerebellum in one of these animals; after which the animal could no longer support himself on his legs, and appeared paralytic; in twenty-four hours he died in convulsions. Rolando says, that he has constantly observed, that the diminution of the motions was in direct ratio with the lesion of the cerebellum; this is the reason, why the animal was sometimes entirely paralytic, sometimes only on one side; at other times the exterior and posterior extremities alone remained motionless, according as the cerebellum was wholly or partially destroyed.

Flourens remarks, that if Rolando means to speak of the loss of motion by the loss of the cerebellum, his conclusion is entirely overturned by the facts. Thus we have always different results, always opposition between these two experiments !

Experiment on the Cerebellum of Birds.

Rolando removed nearly half of the right side of the cerebellum of a cock ; instantly the animal was struck with paralysis, and fell on the same side, without being able to use in any way the right leg, or perform the least motion with this leg. Finally, the paralysis extended to both sides. Rolando admits, nevertheless, that this cock sometimes moved his wings and lower extremities. To escape from this contradiction, Rolando attributes these motions either to the mobility of the muscular fibre solely, or to a small remnant of the cerebellum.

This loss of motion is contrary to M. Flourens, since he has shown, that all the motions remain after the ablation of the cerebellum. And to prove, that to this time the action of the cerebellum has been a mystery, he cites three observations of Sancerotte : from a lesion of the cerebellum there resulted a universal convulsion, a kind of shock combined with a trembling ; a dog kept constantly turning himself, rolling over, traversing the room, using his paws continually. A soldier, in whom after a fall a considerable collection was found in cutting into the cerebellum of the right side, kept constantly turning over in bed, and was in such continual agitation, that, when they attempted to replace him, he moved away and became stiff. A ball had passed through the left part of the cerebellum and penetrated to the posterior lobe of the hemisphere of the brain. During the forty-eight hours, that this soldier lived, his judgment was sometimes good, but oftener he was delirious ; he was always in agitation,

turning in his bed from one side to the other, and constantly moving his legs and arms. (See also vol. III.)

In all these cases, the cerebellum has been injured; irregularity of motions ensued, and no paralysis.

Experiments on the Cerebellum of Reptiles and Fishes.

Rolando separated the cerebellum from the medulla oblongata in a tortoise; he became paralyzed, and lived in this condition for ten or twelve days without making the least motion. Another tortoise lived two months, constantly sensible to the slightest touches, but so far immovable, that he could not stir from the place where he was troubled: the same thing occurred to a lizard and two serpents. Two fishes also lost the faculty of moving.

Rolando observed, that injuries made in the cerebellum, healed promptly, and then the pullets, tortoises, recovered their former faculty of motion. The first tortoise, in which he only tore and divided the cerebellum, remained paralytic for many hours; but soon after it acquired a surprising faculty of motion and so great was this, that it stepped with a rapidity four times as great, as it was before accustomed to do. Rolando had the curiosity to examine the cerebellum, which was only covered with coagulated blood; it appeared to him cicatrized and considerably increased in size. Could it be possible, adds he, that the cerebellum, having acquired by means of this cicatrix a greater development, can thus contribute to this unusual agility?

Finally, Rolando gives us the promised explanation of the functions of the brain and cerebellum, and the morbid alterations the most difficult to understand, and all this by the assistance of the new structure of the brain, such as he has described it:

"In considering the hemispheres of the brain, as a mass of fibres, which first unite in bundles in their crura, then diverge and ramify to form the corpus callosum, fornix, corpora striata, optic couches, &c., we find the greatest analogy for maintaining, that these parts ought to enjoy an exquisite mobility, which being destroyed, increased, or augmented, enables us to explain the different morbid conditions, the seat of which has heretofore been believed to be in the cerebral mass, without its being imagined, that it was a true alteration of this organ.

Now, continues Rolando, is it not true that if, in tearing, bruising, or destroying the hemispheres, we produce heaviness, madness, stupor, whenever we observe a simular condition, in consequence of a morbid cause, as in lethargy or apoplexy, we ought necessarily to suppose, that the energy of the fibres of the hemispheres is more or less deeply altered? On the contrary, if the activity of the cerebral fibres is increased, we shall observe, that the operations, which are produced or modified by the cerebral organs, are also increased, as is observed in the different species of mania."

Let this pass, although I by no means comprehend how any movement whatever can produce any other function, than that of communicating this motion to other parts. But let us follow the list of hypotheses.

"But how," demands Rolando of himself, "can the cerebellum be the organ of motions which take place in muscles, in such a way, that, if it becomes altered, these motions become uncertain and vague, and that they cease entirely, when the organ is completely removed? I had at first suspected, that the corpora striata were destined for this object, but a more attentive examination of the structure of the hemispheres of the brain, and the resemblance of some of the apparatus of the torpedo, with the cerebellum of birds, convinced me, that this part of the brain was a

true electromotor, in which is secreted a fluid analogous to the galvanic fluid, which being then transported by the nerves which serve it as conductors, went to stimulate the muscles of locomotion."

"In fine, if an apparatus composed of different non-metallic substances, such as schistus, carbon, muscular flesh, cerebral substance; if the electrical organ of the torpedo, silurus, gymnotus, composed of a gelatino-cartilagino-albuminous substance, and other similar substances, is fit to prepare and develop a very large quantity of the electric fluid capable of giving violent shocks, why could not a similar principle, such as the nervous fluid, be formed by the numerous laminæ of the yellow and cineritious substance of the cerebellum? What can be found more evident to establish that the cerebellum is an organ, whose structure is precisely similar to the apparatus of Volta? What other proof can we desire, to demonstrate that the cerebellum prepares a fluid analagous to that which the Voltaic instrument developes? What more direct inference can be made, if we observe that all the influence of the nervous fluid on the muscles of locomotion ceases, if this organ is injured or destroyed? It appears to me, that no one has insisted upon the necessity of admitting a particular mechanism, by means of which the fluid prepared in the cerebral electromotor, can be transmitted to the central extremity of the nerve, that may be regarded as a conductor by which this fluid is enabled to pass, in order to irritate the muscles which are to be put in motion."

The hemispheres of the brain are then the principal seat of the proximate cause of sleep, insanity, stupor, apoplexy, melancholy, and madness. The diseases of the cerebellum, *medulla oblongata*, or of some nervous branches, will give rise to the different species of paralysis, whilst the cause of epilepsies and all spasmodic affections, is an irritation either produced at, or transmitted to, the origin of all the conductor nerves,

that is to say, from the medulla oblongata to the neighbouring parts.

Unfortunately for these ingenious explanations, M. Flourens denies, from his own experiments, that the cerebellum presides over motion; he only makes it the regulator of the motions; in the second place, is it really true that the cerebellum is an electromotor? The new discoveries in physics and chemistry always become the war-horse of the physiologists. I have already proved, that the cerebellum cannot be compared to the galvanic pile, or to a Voltaic apparatus. It is, like the hemispheres, a nervous and fibrous membrane, white on its internal surface, covered with a non-fibrous substance, of a grayish color externally. This membrane is not always folded in parallel layers, but in different directions. In consequence of this kind of folding, there is always between two pretended leaves, two layers of a non-fibrous substance, and these two layers are in immediate contact with the vascular membrane, which exists here, as in the anfractuositities of the convolutions of the hemispheres, in all the folds, or, to speak more correctly, which envelopes and penetrates the whole surface of the non-fibrous substance of the cerebellum.

It is then with the explanations of the functions of the nervous system, and their application to the knowledge of morbid causes, as with the discoveries that Rolando has made on the new structure of the brain.

At the end of the experiments of the Turin professor, M. Coster has tried to prove, that the results obtained by M. Flourens, are similar to those obtained by Rolando. "I defy," says he, after having copied certain passages of Flourens, "the most subtle mind to find the least difference between the results announced in this passage, and those related by Rolando, except that the subject of the experiments of the one was a pullet, and that of the other, a pigeon." Where it is said in the report of the academy: "And cer-

tainly no one had suspected, that the cerebellum was in any way the regulator of the motions of progression of the animal." M. Coster replies; "I ask a thousand pardons of the academy; but this was one of the first things I learnt in commencing my medical studies. This discovery is so well known in the school of Turin, and in those of the island of Sardinia, that it is one of the principal subjects of discussion with the new students." M. Coster has manifested an extraordinary degree of gratitude, in reclaiming the property of his old professor from the encroachments of M. Flourens. "For fear," says he, "of being taxed with injustice and bad faith towards the French physiologist, whose works are later by thirteen years than those of Rolando, I will extract textually from the above mentioned work of Rolando the experiments that are there related, and I will place them parallel with the results of those of which the celebrated Cuvier has been the reporter. It will be seen, that these experiments and results have such an air of paternity, that it requires nothing less than the acknowledged ability of the French experimenter, to induce us to believe, that it is not by chance, that he finds himself on the same track with the professor of Turin." As M. Flourens has preserved the same order, the same course in his researches, commencing by the brain of the mammalia, their cerebellum, and ending by the cerebellum of reptiles and fishes; as he speaks also of galvanism; as he terminates his work by researches on the action of nerves, precisely like Rolando; as I think I can perceive here and there symptoms of a similar hazard; and as it is not the part of sound philosophy to believe in chance, I conclude that for some years a new constellation reigns with an equal influence over our young experimenters.

The reader will recollect that in the third volume I have made some observations in opposition to the experiments of M. Flourens; it appears, according to M. Coster, that I at the same time attack the experi-

ments of Rolando, although I am myself ignorant of it; he believes it his duty to answer me.

1st. He wishes to prove that ablation is a good method of learning the special function of a single part of the brain. "If ablation," says he, "is not in all cases a necessary means of arriving at the knowledge of the special function of an organ, it must be admitted, that this method is at least one of the most certain in a great variety of circumstances. I suppose that a man, struck for the first time with the impression of light, is ignorant of the organ, the external instrument, by means of which this unusual impression is communicated to him; after having successively tried to deprive himself of the use of his ears, mouth, and nose, he comes to his eyes, closes them, and immediately he ceases to see; will he not then conclude, that the eyes are the instruments which transmit to him the impressions of light? Is not privation, or if you will, ablation, a sure means of judging of the special function of these organs? Let us apply this reasoning to the seat of perception of light. First we discover that it must be in the brain; but in what part? In order to know this, we successively cut away the superior thalami of the cerebral lobes, the animal continues to see; we destroy the tubercula quadrigemina, immediately the animal becomes blind; hence we conclude that the cerebral lobes are not the organ of vision, since it continues after they are destroyed; but the tubercula quadrigemina are so, and this is one of their special functions. It is then false to say that ablation is not a good method of ascertaining the special function of an organ."

The experiments of Rolando and Flourens have demonstrated, that so soon as the hemispheres are removed, the animal ceases to see and hear, although the eye, ear, and tubercula quadrigemina remain untouched. The hemispheres are then the organ of the two special functions, hearing and seeing!

Lastly, there exists a great difference between a

sense entirely isolated, and different cerebral parts so intimately connected with each other. And when I said that ablation did not make us acquainted with the special function of an organ, I spoke of the cerebral organs. I defy any one to discover any special function whatever by ablation, unless this function be previously known. There were many proofs that the hemispheres were the organ of the will and intelligence; that the corpora quadrigemina were a ganglion for the optic nerve; for a long time the nervous fluid for motion has been said to be secreted in the cerebellum. You have removed the pineal gland; what is its function? Take away the *corpora mamillaria*; the *infundibulum*, the *septum lucidum*, *fornix*, anterior commissure, &c. &c., and teach me their special functions! and again, in wounding a part, are you sufficiently skilled to limit this lesion exactly to this part? do you know the limits of a cerebral part which constitutes an organ? Why has the organ of vision so long been sought in the optic thalami? and why do Rolando, Rudolphi, &c. still find it there, even in the lesions and experiments by mutilations? &c. &c.

M. Coster continues: "Let us suppose," says Gall, "that M. Flourens wishes to verify by the ablation of the cerebellum, whether this part is or is not the organ of the instinct of propagation, how can he make the animal live sufficiently long, to be able to say whether he possesses or has lost the instinct?"

"If it is recollected that the experiments of Rolando demonstrate that tortoises live many months after the ablation of the brain and cerebellum, this time would seem to be sufficient to make the necessary observations on both these organs, and to become assured of the nature of their special functions."

After removing the hemispheres, the animal neither sees, hears, feels, nor has will nor intelligence, with what can he feel the instinct of generation? after having removed the cerebellum, the animal is either entirely paralyzed, or has only irregular motions, how

can he copulate? Lastly, show me an example of a similar act in an animal deprived of his cerebellum. Cause an animal to suffer in any manner whatever, deprive him of his liberty, take from him his accustomed food, and see how much difficulty you will have in making him desire to copulate. M. Coster does not admit as authority, the different results that myself and my friends have obtained. And as to myself, I have too much experience to confide in the decisions of commissions of the academy. It is hardly possible that academies, in constituting themselves judges of every novelty, can avoid committing themselves. As a proof, among others, see the report on our memoir, that in the contradictory experiments of Legallois, &c. &c. As another proof, M. Coster himself, who says, in opposition to M. Flourens and his reporter, that the cerebellum is neither the balance nor the regulator of the locomotive motions; that it is only the centre from which proceed the irritations that the conductor nerves transmit to the muscles; that the true regulator is the brain; and that the cerebellum influences the intensity of the motions, but not their regularity.

M. Coster again observes, that, if the cerebellum has no other special function, than that of exciting the venereal act, when this organ acts alone, the cerebral lobes being destroyed, it ought especially to determine the state of the genital organs, since, all things being equal, a cerebral organ performs its function as much more irresistibly as its action is less counterbalanced by that of other organs. This admirable reasoning induces me to think that, if at any time M. Coster should have need of a more energetic will and a more correct judgment, it will be necessary to remove his cerebellum, stomach, &c. Compare what I have said on this subject, vol. III, page 407-415, and it will be seen that M. Coster, in order to give a little plausibility to his cause, has been obliged to mutilate at least two thirds of my objections.

Experimental Researches on the Properties and Functions of the Nervous System in Vertebrated Animals, by P. FLOURENS, 1824.

It has been said in some journals, that the works of M. Flourens were but a repetition of those of Rolando, published in 1809. In order that this assertion may be tested, M. Flourens has first published, at page 273 and the following, a literal translation of the experiments of Rolando. We must now examine, if by this M. Flourens has succeeded in maintaining, not precisely his modifications, but the novelty and originality of his experiments and results. "I have not spoken" says he, "in the preamble of my memoir, of the work of Rolando, because it was entirely unknown to me. Under all circumstances, I should have had fewer motives for noticing him, as his work, in my opinion, does not add any precision to the results already obtained by the works of Haller, Lorry, Ziun, &c.

"Haller, Lorry, Ziun, Fontana, and twenty others ought necessarily to produce, in their experiments, all the phenomena that I have produced in mine, since the parts on which they experimented were the same as those on which I myself operated; but, 1st, they only perceived these phenomena in mass, and all the results of detail escaped them. 2d, even as to the results which they did obtain, they knew not to what organ to refer them, because they were never sure of the organ which they had wounded. 3d, by not insulating the organs, they of course could not insulate the phenomena. Thus they were never able to excite the one to the exclusion of the others. In a word, they had observed most of the phenomena, they had experimented on most of the organs, but they did not know to what organ in particular such or such determinate phenomena belonged; and this localization of phenomena by the localization of

the organs, was precisely the end that it was necessary to obtain."

The merit of M. Flourens would consist then in having localized both the organs and results. He admits six different divisions of the nervous system: the hemispheres, the cerebellum, the *corpora quadrigemina*, the *medulla oblongata* and the *medulla spinalis*. It seems to me, especially in animals, and more particularly so in the lower classes, that these parts are so far separated from each other, the cerebellum and the tubercula quadrigemina, the medulla oblongata and the medulla spinalis, so much concealed under the hemispheres, that the experiments must find a natural localization of the organs of M. Flourens, and that, consequently, most of their results at least should be equally localized.

After having found fault with the method of Rolando, M. Flourens denies his results whenever they differ from his own.

"In one of the experiments of Rolando," says he, "vacillation in the motions (*ivresse*) comes from the optic thalami, and the tubercula quadrigemina; in another it is derived from the cerebral hemispheres. In one the mutilation of the cerebral hemispheres produces heaviness and immobility; in the other it produces vacillation, that is to say, want of harmony, an ungovernable excitement of the motions; in one the animal is stupid and calm during the mutilation, and in another he seems to suffer; finally in one, neither noise, food, nor water excite the animal; in another, he drinks and eats. Thus, according to Rolando, the cerebral lobes sometimes produce stupor and sometimes excitement of the motions; sometimes the animal is stupid and calm; sometimes he suffers, and then he eats and drinks. Finally, it is sometimes the optic couches, sometimes the tubercula quadrigemina, sometimes the cerebral lobes, that produce these phenomena of excited action. Rolando then confounds all the phenomena, as he also confounds

all the organs from which these phenomena are derived, and that because his method does not separate the parts. With an isolated method he would have seen that stupor came from the cerebral lobes, excitation, from the tubercula quadrigemina, and irregular action, from the cerebellum."

This confusion of phenomena will constantly take place, as experience has demonstrated it, since physiologists have supposed that they could discover the functions of the nervous system, especially those of the cerebral parts, by means of mutilations. And I have proved, and I will again prove, that it is impossible to avoid this disorder by any method whatever. Rolando expressly says: "The hemispheres of the brain are then the principal seat of the proximate cause of sleep, idiocy, stupor, apoplexy, melancholy, and insanity. The diseases of the cerebellum, *medulla oblongata*, will give birth to the different species of paralysis, whilst the cause of epilepsy, &c., comes from an irritation produced or transmitted at the origin of all the conductor nerves, that is to say, at the *medulla oblongata*, &c." He has then insulated the organs and results.

"But," continues M. Flourens, "what is of peculiar importance to be remarked here, is that Rolando nowhere speaks expressly of the loss of the intellectual and sensitive faculties by the ablation of the cerebral lobes. He has even so little suspected this loss, that he says of a hen, whose cerebral lobes had been mutilated, that she ate and drank; and of a raven, according to him in the same condition, that at the sight of a dog or moor-hen, his deadly enemies, he no longer became enraged. Rolando has nowhere established this important fact, that all the intellectual and sensitive faculties reside exclusively in the cerebral lobes."

Rolando, according to Flourens, has done nothing but mutilate the parts on which he has operated; and according to the same M. Flourens, a very limited portion of the cerebral lobes is sufficient for the exer-

cise of their functions, page 310. Consequently his hen with mutilated lobes could yet eat and drink. But it is M. Flourens himself who is at fault, since at one time he makes the cerebral lobes the seat of the intellectual and sensitive faculties, and at another he makes a hen, from which he has entirely removed the cerebral lobes, eat, drink, and walk; qualities, according to his own declaration, intellectual and sensitive. I read with astonishment, at page 87, the martyrological biography of a fine and vigorous hen.

"This hen, deprived of her two lobes, lived ten entire months in the most perfect health, and she would have still been alive, if, at the time of my return to Paris, I had not been obliged to abandon her.

"During all this time, I did not lose sight of her for a single day; I spent many hours of every day in observing her; I studied all her habits; I followed her in all her actions, and noticed all her ways, and the following is an account of the observations which this long study has furnished me."

This important study of a hen deprived of all her intellectual and sensitive faculties!!

"As soon as the two cerebral lobes were removed, the sight of both eyes was lost. The animal no longer heard, nor manifested any sign of volition: but she kept herself perfectly balanced on her legs, and walked when irritated or pushed; when thrown in the air she flew, and swallowed water when it was put in her beak."

Believe this, my kind reader; to stand erect, walk, fly, swallow, are no evidences of volition!

"In other respects she stirred not, unless irritated. When placed on her feet, she remained on them; when laid on her breast, like hens when sleeping or resting, she continued in this position; she was constantly plunged in a sort of lethargy, affected neither by noise nor light, but from which she could only be aroused by immediate irritations, such as pinching, blows, pricking, &c."

Pricking, pinching, blows have produced determinations in an animal, without their being perceived! This is a little too much even for Baron Cuvier.

"Six hours after the operation, the hen assumes the attitude of profound sleep; that is to say, she turns back her neck, and conceals her head under the feathers of the upper border of her wing, as animals of this species do when sleeping.

"I left her for nearly a half quarter of an hour in this state; I then briskly irritated her; she suddenly started from her sleep; but hardly was she awake, when she again relapsed into a deep sleep."

All this proves to M. Flourens, that the seat of the intellectual and sensitive faculties is in the cerebral lobes!

"Eleven hours after the operation, I caused the hen to eat by opening her beak and thrusting in food, which she swallowed very well.

"The next day she aroused a little from the sleep in which she was plunged, and in doing this she exhibited the manners of a hen awaking.

"She shook her head, moved her feathers, sometimes even cleansed them with her beak, and sometimes changed the foot on which she stood; for often she slept resting on one alone, as birds generally sleep."

Proofs still more evident that the hen has neither instinct, intelligence, will, nor sensation!

"In all these cases, we should say that a man was asleep, who without entirely awaking, and still half asleep, changes his position, takes another as a relief from the fatigue occasioned by the former, takes a more easy one, often stretches himself, straightens out his limbs, gapes, shakes himself a little, goes to sleep again, or remains thus drowsy."

Thus a man half awake is a man completely deprived of will, memory, sensation, &c!

"The third day, the hen is no longer as quiet as usual. She goes and comes, but without motive or end; and if she meets an obstacle on the way, she

knows neither to avoid it, nor turn from it. Her comb and gills are red as fire, the skin burning; she is seized with acute fever. I gave her water in abundance.

"In other respects, no sign of convulsion, no want of harmony in the motions appears; and two days after this there is no more agitation or fever; the hen becomes calm and drowsy as usual.

"I pass over many articles of my journal, and come at once to the second month of the operation.

"The hen enjoys perfect health; as I feed her with great care, she has become very fat. She sleeps a good deal, and when she is not entirely asleep, she is drowsy.

"For many days long fragments of the cranium, exposed to the air, have exfoliated and fallen off. The cicatrix is rapidly forming.

"Five months after the operation, I never saw a fatter or fresher hen than this one. The wound of the cranium; is entirely cicatrized a fine, white, and smooth skin covers the whole of its surface; and below this skin a new long layer is formed, which, although as yet very delicate, is however very solid.

"I have kept this hen from feeding, on different occasions, for three whole days; then I have put food under her nostrils; have plunged her beak in grain; have placed grain in the end of her beak; have dipped it in water; have placed her on a heap of corn: she has neither smelt, swallowed, nor drank; she remained immovable on the heap of corn, and would most assuredly have died there of hunger, if I had not fed her by putting the food in her throat.

"Twenty times, instead of grain, I have put small flint stones into the bottom of her beak; she swallowed them as she would have swallowed grain.

"Finally, when this hen met with an obstacle in her path, she fell against it, and the blow arrested and stopped her; but to fall against a body is not to perceive it by the touch. Never did the hen feel, grope,

or hesitate in her step; she meets with obstructions, and falls against objects, but she touches nothing.

"Thus then the hen without lobes has really lost her sense of taste, touch, and smell, with vision and hearing. Yet none of these senses, or, to speak more correctly, no organ of these senses has been directly affected. The eye is perfectly clear, and the iris movable. Neither the organ of hearing, taste, nor touch has been injured. A remarkable circumstance! There is no longer sensation, although the organs of the senses exist. It is not then in these organs, that sensation resides.

"Finally, the hen without lobes has lost all her senses, for she neither sees, hears, smells, tastes, nor touches any thing.

"She has lost all her instincts, for she no longer eats of her own accord, however long she has been fasting; she moves not, however much she is incommoded; she never defends herself against other hens; she knows neither to fly nor to fight; she has no more desires for coition; the caresses of the male are either indifferent to her or unperceived by her.

"She has lost all intelligence, for she neither wishes, remembers, nor determines upon any thing.

"The cerebral lobes are then the sole receptacle of the sensations, instincts, and intelligence."

We have now come to a conclusion, which should astonish all physiologists by its novelty.

Here terminates the precious narrative of the life of our heroine. When M. Flourens and his reporter shall have demonstrated to me, that to stand erect, to walk, to decide in consequence of extraordinary irritations, to fly, swallow, turn back the neck, conceal the head under the wing, shake it, put the feathers in motion, sharpen and clean them with the beak, alternately change the feet to rest them, stretch out and straighten, shake and resume the equilibrium, raise up and resist the efforts that are made to open the beak, as the pigeon did, whose two lobes were equally mutilated,

page 32, &c., are the undeniable proofs of the absence of sensation and volition, &c., I will admit the conclusions of M. Flourens.

Some weeks since, I found in my garden a tame jack-daw; he was easily caught; surrounded by sparrows and hens he continued perfectly quiet. I carried him to my apartment, and ascertained that his thigh was broken. I placed him in a cage; he remained perfectly still, neither ate, drank nor flew; I thrust food to the bottom of his beak, he rejected it; two days afterwards he swallowed, after this he ate, drank, and became wild, and flew away. He now returns every day, with the leg hanging, to seek food. I only mean to say by this, that it takes much less than the ablation of the cerebral lobes, to suspend, while the animal suffers, the exercise of his faculties.

As the hen of M. Flourens evidently manifested sensation and volition without cerebral lobes, Rolando, at least, has not established a hazardous conclusion. He speaks often of drowsiness and stupor, which is nearly equivalent to the loss of the intellectual and sensitive faculties. And if Rolando has not expressly said, that all the intellectual and sensitive faculties reside in the cerebral lobes exclusively, M. Coster his pupil has supplied the omission. Before the publication of the experimental researches, 1824, and before this reproach of M. Flourens, M. Coster had already said, *Archives Generales de Medicine*, March 1823, page 376: "The experiment that I have just mentioned, led M. Rolando to deduce very simple consequences, which will occur of themselves to the mind of the reader. In fact if the lesion, compression, destruction, or ablation of the hemispheres of the brain is constantly followed by an alteration or a complete deprivation of the intellectual functions, we are forced to conclude, that the hemispheres are the organ which presides over the functions, and that when they are interrupted by a morbid cause, it is in the hemispheres, that we must look for the seat of those alterations, which produce similar effects."

Finally, what is there new in the conclusion of M. Flourens, since my works? and as to the results obtained in a frog and hen, &c., are they applicable to man?

M. Flourens promises to show us by and by, by his new experiments, that a very limited portion of the cerebral lobes is sufficient for the exercise of their functions. It is then true, as the German philosopher, that I have already cited, says, that the brain of a frog might very well be the seat of the mind of a Newton. After this, what will become of the comparative anatomy and physiology of the brain? Ah! how much superfluous expense does nature give herself, to bestow a little more intelligence on the monkey than on the tortoise, and a little more on man than on the monkey!

M. Flourens says: "What was most difficult and which has cost me the most pains to distinguish in the phenomena of the cerebellum, was the principle of coördination entirely different from the principle producing the motions, and of which, I dare believe with Baron Cuvier, that as yet no physiological idea is entertained."

No doubt that physiology will soon be encumbered with incomprehensible ideas. To this very time physiologists have believed, that they could admit a difference between the organ that perceives, and the organ which receives the impression, between the organ which commands, directs, rules, and the organ that executes. But, it is neither the cerebellum, nor the *medulla oblongata*, nor *spinalis* which produces motions. The nervous system is the source, the indispensable condition of the motions that are executed by other instruments. Without volition, sensation, intention, no united or coördinate movement can take place. It is then contrary to reason, to look for the regulator or balancer of the motions in any other place, than that where perception takes place, where the seat of volition exists. Can we be astonished that this coördinating principle has cost M. Flourens so much labor? Since this principle exists not in facts, it was requisite that the experimenter should distil it from his brain.

"To resume, there is nothing in Rolando's work," says M. Flourens, "of the direct loss of vision and hearing by the loss of the cerebral lobes."

The loss of audition and vision or rather the loss of the perception of light and sound, is effected in the same manner by the ablation of the cerebral lobes, as the loss of every other faculty belonging to the two hemispheres of the brain. When Rolando mentions stupidity, heaviness, it may well appear to him superfluous to specify the loss of vision and audition; and when in the morbid affections of the cerebellum, the functions of sight and hearing are changed or lost, is it the cerebellum also which is the seat of them?

"Nothing is said of the *croisement* of the loss of vision by the loss of these two organs."

I hope M. Flourens will not attribute to himself the discovery of this *croisement*.

"Nothing is said respecting the preservation of all the intellectual and sensitive faculties, by the preservation of a single cerebral lobe."

See my works, volume II. page 234, octavo edition.

"Nothing is said of the regulating principle of the movements of locomotion and prehension, the seat of which is the cerebellum."

Novelties coincide with extravagancies; when I write a history of the vagaries of the human mind, the cerebellum, the regulator and balancer of motion in company with a very limited portion of the brain to perform all its functions, shall hold one of the principal places.

"Nothing is said of the formal independence of the locomotive and sensitive faculties."

This is not so, for Rolando has very well, and in many places, observed this difference. An idea, too, which is ancient and very generally admitted.

"Nothing, finally, is said touching the precise limit which separates the nervous parts, susceptible of exciting muscular contraction, for those which are not susceptible."

M. Flourens has been already told, that there was nothing new in all this.

After censuring the experiments of Rolando, M. Flourens lays down the following propositions:

"1st. There are in the nervous centres, distinct organs for sensation and motion, and consequently the property or faculty of sensation is essentially distinct from that of motion."

As M. Flourens has only the cerebral lobes, the cerebellum and the *medulla oblongata*, in view here, what will he do afterwards, with the anterior and posterior nerves of the spinal marrow?

"2d. The *medulla spinalis*, *oblongata*, tubercula quadrigemina, are alone susceptible of exciting *immediately* muscular contraction; the cerebral lobes and cerebellum are not susceptible of it."

Unless M. Flourens has recourse to the distinction of *mediate* and *immediate* influence, a thousand pathological facts of symptoms produced by the lesions of the brain and cerebellum, will disprove his assertion.

"3d. Sensations, instincts, and volitions reside exclusively in the cerebral lobes; as also all the intellectual and sensitive faculties."

Read my work, vol. II. page 153 and the following, where you will at the same time find, page 67, 69, &c., discussions on the question, viz: the functions that are usually attributed to the mind or brain; and whether we may consider the brain as the organ of all the operations of animal life? and page 69, the reasons which seem to prove, that the brain is the organ of all the sensations and all the voluntary motions. But, as if I had foreseen that the day would come, when M. Flourens would cut away from a rabbit all the cerebral parts, with the exception of the *medulla oblongata*, and that this animal would not only breathe still, but that being strongly pinched, he would be troubled and cry out, page 183; that consequently there would yet remain sensation and volition; as if

I had anticipated all this, I say, I have added other reasons, page 85, which seem to prove, that other nervous systems, entirely independent of the brain, may also produce sensations and voluntary motions. I have even established this idea on the existence of animals in whom we cannot deny voluntary motions, the senses of touch and taste, although we cannot discover any thing in them which can be compared with the brain. These animals experience hunger, seize their prey, eat; and since they have no brain, these sensations must in them have their seat in other nerves. Add to this, that every nerve destined to any particular function whatever, has, as well as the brain itself, its particular origin, its particular apparatus of supply, its final ramification, and forms even in itself a particular organ. Why should not a similar nerve thus form a whole relative to its destination? why should it not embrace a sphere of activity which should be peculiar to it? —and many similar reasons; which weaken and greatly limit the pretended exclusive property of the brain. I again ask, in this rabbit deprived of brain, cerebellum, and tubercula quadrigemina, and in those monsters that are born without brain or cerebellum, which cry and suck, what organ has determined the will to cry and suck, and what organ has rendered the motions requisite for sucking and crying, coördinate? Ought we not finally become more circumspect before we establish laws or principles?

“4th. The coördinate principle of the movements of locomotion and prehension, resides exclusively in the cerebellum.”

This is in contradiction to the preceding propositions; for the coördinate principle is inseparable from that of sensation and volition, properties of the cerebral lobes alone, according to Flourens.

“5th. As the loss of the cerebral lobes does not in the least change the regularity nor order of the motions, so the loss of the cerebellum does not in the

least degree, alter the regularity or the energy of the sensations. The centre of the sensations is then essentially distinct from the centre of movement, and the sensitive faculties, from the locomotive faculties."

Stupidity, heaviness, the loss of sensation, volition, &c., will they not then in the least change the regularity nor the order of the motions?

"6th. In voluntary motion, it is necessary to distinguish the action of the nerve, that of the spinal marrow, the cerebellum, and that of the cerebral lobes. The nerve excites immediately muscular contraction; the spinal marrow connects the different contractions in united motions; the cerebellum coördinates these movements, and renders them determinate: walking, flying, standing, &c.; the cerebral lobes perceive and will."

To will and perceive are absolutely the first condition of all united and coördinate movement. How then can we believe in like motions, when the cerebral lobes do not exist, when they have been violently removed, and when they are alone the seat of will and sensation?

"7th. The loss of a single cerebral lobe only induces the loss of vision of the opposite eye; all the other intellectual and sensitive faculties remain."

The *intellectual* faculties, that the hen with one cerebral lobe manifests! As to man, I have already indicated the page of my work where this idea may be found developed, in a manner much more rational and practical.

"8th. The loss of one of the tubercula quadrigemina, also, occasions the loss of sight of the opposite eye."

Read again my large work, vol. i. page 112, on the optic nerve, and my answer to the report of the French Institute, page 101, &c., you will there find this anatomical fact very circumstantially announced.

"9th. The loss of both cerebral lobes renders the animal blind; neither the iris, nor retina, nor optic nerve, are changed by this loss."

What then : the loss of the two cerebral lobes deprives the animal of the perception of every impression whatever. Why then, only of the perception of the impressions of light ?

"On the contrary, the loss of the tubercula quadrigemina, when it is complete, instantly paralyzes the iris, retina, and optic nerve."

A result certainly easy to find, since we have demonstrated, that the optic nerve takes its first visible origin from the corpora quadrigemina. It is very possible, that hereafter, when experimenters shall know the different origins of the optic nerve, that they will not find complete blindness instantly occurring on the destruction of the corpora quadrigemina.

"The origin of the sense of sight is then distinct in the cerebral mass, from the seat of the sensation of vision. The origin of the sense resides in the corpora quadrigemina; the principle of the sensation, in the cerebral lobes."

M. Flourens, apparently the better to impress his readers, says often, as here, with much pretension, what no one is ignorant of, for instance, the distinction between the sense and the perception of impressions upon the senses.

"10th. Each of the other senses, smelling, tasting, hearing, has equally, in the cerebral mass, an origin distinct from the centre, or sole receptacle of the sensations. There are then in the cerebral mass, distinct organs for the senses, sensations, and motions."

Why so many evasions ? Why has M. Flourens, a few lines back, stopped so complacently at the sense of vision ? and why does he admit in the cerebral lobes, the senses of tasting, hearing, and seeing, which anatomy points out to us in another place, since it suffices that the lobes are the organ of all perception ? When these lobes are removed, there is no longer a perception of the natural wants, neither hunger nor thirst, &c., and hunger, thirst, and the natural wants, should they also have their seat in the cerebral mass ?

"11th. When the cerebellum is entirely removed from an animal, all the regulated movements of locomotion and prehension are at once lost; but all the regulated motions of conservation (respiration and circulation) remain. The movements of locomotion are then essentially distinct from the motions of conservation."

"Every part essentially distinct from the nervous centres, has then an office to perform, peculiar functions, distinct and specific properties."

The whole of my treatise on the plurality of organs for the different instincts, propensities, intellectual faculties, essentially different, is based on this principle.

"This office, these functions, these properties now being known, every one hereafter will see the facility that pathology will have, in inferring an alteration of parts from an alteration of properties, and reciprocally a lesion of properties from an injury of parts; a double decision which is the end and perfection of all pathology."

This would be an excellent method of diagnosis, if in nature, and diseases, all the phenomena occurred in an isolated manner. But the practitioner will never forget that, throughout the system, the organs are held together, reciprocally influence each other, and easily produce a confusion of intricate causes and effects, &c. &c. Here again M. Flourens has followed Rolando, and this last, the medical doctrine of all ages.

Definitively, then, the results and the explanations of the experiments of Rolando and Flourens, are, in many respects, opposed to each other, as it has heretofore happened to all experimenters by lesion and mutilation; as it must necessarily always happen; and as it has always happened, it also happens to our two estimable associates, that always, sooner or later, we find the promises of experimenters by lesion and mutilation, evaporated almost to zero.

Let us now leave the society of Messrs. Flourens

and Rolando, and see what remains to be said on the ulterior experiments of M. Flourens. I will not repeat here what I have already said in the third volume of this work, on this subject.

M. Flourens begins by explaining to us why, before him, all experimenters, as I have just said, obtained only complex phenomena, and vague and uncertain conclusions. They always experimented on many parts of the nervous system together, and they never properly isolated the other parts from that which was experimented upon, or they only experimented on certain parts of the nervous system, and then attributed to the whole of this system, effects, which almost always, belonged only to the parts experimented upon; they then always confounded the results, given by one of these methods, with those afforded by the other.

In order to escape these shoals, he has successively experimented separately on the nerves, the spinal marrow, the brain, and the different parts of the brain. In operating on each of these parts, he says he has taken the greatest and most scrupulous care not to interfere with other parts, and thus to avoid all foreign complication.

There is no doubt, but that this is one of the causes why the experiments by mutilation and lesion, have been up to the present time so contradictory, in the hands of different experimenters, and why the results have always been either barren, or at least vague, uncertain, accidental, &c. There is also no doubt but that the method of M. Flourens would be infinitely preferable to that of his predecessors, if the execution of it were practicable. When we read of the experiments of our physiologists on the brain, we are almost induced to believe, that the whole nervous system, especially the brain, cerebellum, &c., are only composed of pieces of wax applied one over the other. One is removed, and another is removed, and the loss of one or another function instantly takes place. No one thinks of the state of suffering, trouble, and uneasiness

of the animal, of the blood that inundates the injured parts, and which it is necessary to stanch at every instant, which very often immediately coagulates, and it requires such compression, friction, and searing, that the part operated on rarely presents a smooth and clean surface, to enable us to ascertain with exactness how deep and to what extent the lesion or extirpation has been practised. They always assure us that the experiments have been a thousand times repeated; but, with a few exceptions, it is hardly possible to perform twice, absolutely the same operation, which explains why every time, unless the experimenter wishes to impose upon us, the accidents attending the operation vary; which also brings about a variation in the results. This single circumstance is generally sufficient to disgust, with this sort of experiments, all those who seek new truths with candor, without self-love, without the incitements of a fugitive vanity. M. Flourens assures us that, in order not to confound the parts on which he has operated, and not to attribute a result to another organ than that to which it belonged, he has by turns experimented separately on the nerves, spinal marrow, brain, the different parts of the brain, and that, in the exploration of each of these parts, he has taken the most scrupulous pains to interest that part only on which he was experimenting, and by this means to avoid all foreign complication. He adds, that it is always necessary to be as careful as possible of those parts which furnish blood; 1st. Because the loss of blood greatly abridges the life of the animal, and it is quite necessary that the animal should live to furnish the results of the experiment; 2d. Because the blood being effused in the cerebral mass, produces those compressions, the results of which being confounded with those of the experiments, complicate and often even destroy them.

I conclude from this that M. Flourens knew perhaps better than his predecessors, with what precautions similar experiments ought to be performed.

But is it not to be feared, that by this he has in a great measure pronounced his own condemnation? Is this localization of the cerebral parts and their results possible? Where is the anatomist or physiologist, who knows with precision all the origin, the extent, the ramifications, and connexions of an organ? You remove the cerebellum, at the same instant you wound very seriously the medulla oblongata and spinalis, the annular protuberance, the tubercula quadrigemina; consequently your results belong not only to all these parts, but also to all those, that communicate with these mediately and immediately. You believe that you have isolated the tubercula, but these tubercula have connexions with the corpus olivare, the medulla oblongata, the cerebellum, with the sense of vision, and with many convolutions; the optic thalami, and the corpora striata, are connected below with the crura of the hemispheres to the annular protuberance, the medulla oblongata, the pyramids and spinal marrow; above, with all the cerebral membrane, all the convolutions, the grayish non-fibrous substance; by their surface to the different commissures, such as the anterior commissure, the great commissure or corpus callosum; to the fornix or *septum lucidum*. Thus there does not exist a cerebral part, of which we do not know that it has very multiplied relations with other parts. I do not even except the corpora mamillaria, the pineal gland, infundibulum, &c.

And surely the connexions that are unknown to us, are still more numerous. This being established, how can we present the reciprocal influence of all these parts, especially when they are irritated, injured, lacerated, or removed? And how can we isolate their results? This beautiful idea of localization is then only a fine and presumptuous chimera.

To arrive at a cerebral part, we must perforate, break or cut the bony parts; we must wound and tear violently, the different membranes which envelope the nervous system, and which establish, among all its

parts, an intimate connexion by means of the vascular and arachnoid membranes. And as these membranes penetrate not only the ventricles and the convolutions, but also the whole cerebral mass, the loss of blood, their irritation, inflammation, &c., must inevitably complicate the experiment and its results.

M. Flourens frequently makes horizontal sections of the cerebral parts; this procedure would imply that the organs on the different parts of the brain, are composed of horizontal layers placed one upon another. This disposition does no where occur, not even in the annular protuberances. Upon the anterior pair of the tubercles, on the surface of the brain and cerebellum, &c., you can remove a very delicate layer of non-fibrous substance; but this substance already contains the early rudiments of an infinite number of nervous filaments, which are continued into the interior of the cerebral masses. Throughout, the white filaments of the cerebellum, brain, corpora striata, optic thalami, crura of the brain, annular protuberance, and tubercula course and diverge from below upwards; throughout, they plunge either diagonally, perpendicularly, or obliquely towards their apparatus of supply; and from thence to their ramifications. The converging fibrils in inverse order arrive from the surface of the brain and cerebellum to form the different commissures. Thus this art, so much recommended and extolled, of removing the organs by layers, is in opposition to the structure of the cerebral parts.

They talk to us of the medulla oblongata, the annular protuberance, as cerebral parts that it would be easy to isolate: not more than the tubercular quadrigemina. These are still a part, the continuation of the bundles of the medulla oblongata and medulla spinalis. They are at the same time formed by ganglions, one part of which gives origin to the fibrillæ of the optic nerve. So in a great degree, is the medulla oblongata a continuation of the medulla spinalis, besides that it contains many masses of non-fibrous sub-

stances, which, like so many ganglions, are the origin of many nerves of the greatest importance, and which belong to very different functions. The annular protuberance is not alone composed of the nervous bundles of the two hemispheres of the cerebellum, or the commissure of the cerebellum, it is also the continuation of many bundles of the medulla oblongata and spinalis, the anterior and posterior, or inferior and superior, pyramids, and it contains a considerable quantity of non-fibrous substance, placed between the transverse and longitudinal bundles, and which create new filaments for the crura of the brain, the tubercles, &c. We see, then, throughout the brain, the parts very materially complicated, which renders any localization absolutely impossible. This localization only becomes practicable where the particular nerves are already disengaged from the common masses, in order to join the apparatus where the special function takes place. This is applicable to all the nerves which take their origin from the medulla oblongata, &c. &c. More than this, you cannot isolate or localize the nerves of the senses, before they are complete and joined to the apparatus of the sense. The origin of the nerves of taste is confounded with the masses of origin of many other nerves; the auditory nerve is confounded with the nervous and non-fibrous masses of the fourth ventricle; the optic nerves, at first, with all the mass of the tubercles, with the corpora geniculata and their contiguous parts, with the crura of the brain, and with the grayish layer situated immediately behind their junction. The olfactory nerves are at first intimately united with the gray substance placed on the interior and inferior convolutions of the middle lobes, with the anterior cerebral cavities, &c.

Either those who experiment on the brain, and the cerebral parts, have never had a clear and just idea of the organization of the nervous system, or they impudently calculate to make dupes; and they succeed marvellously, since, in spite of the refined precision of

their precepts, they find their readers and judges in a greater ignorance than that in which they themselves are, of the most essential facts of the cerebral organization. See further, my treatise, volume III. page 155, &c., on the mutilations of the brain, as a pretended means of determining the functions of its different parts.

M. Flourens has generally chosen young animals for his experiments on the cerebral mass and spinal marrow. He gives many reasons for this choice. "First," says he, "the bones of young animals being very tender, we experience less difficulty in removing them; in the second place, it is invariably the case, that the younger an animal is, the less he resists mutilations. Finally, and this applies particularly to experiments on the cerebral mass, the sinuses of the dura-mater being comparatively very little developed in the early ages, we have less fear of being embarrassed with blood."

In no experiments on the cerebral mass can we avoid opening the cranium, and incising the membranes. Hence there will always be an effusion of blood. The sanguineous vessels are even more gorged with blood in young animals, for this is the most important and active period for formation and nutrition. The whole cerebral substance is much redder, much more sensibly penetrated with sanguineous vessels at this age, than later. Besides, at this period, the organization of the brain is not yet completed. The non-fibrous substance is still predominant; the whole substance of the cerebellum and brain is yet soft, a kind of gelatinous pulp, much more liable to be crushed or torn. How can any one pretend to judge of alterations of functions, which a little while after birth do not exist, and whose manifestation we cannot expect, until the successive development and maturity of the organs?

Another consideration renders the choice of young animals still more objectionable. The organs of ani-

mal life not being yet formed, they are still under the dominion of vegetative life. Many lesions and mutilations do not produce the same effects, which they produce in an older animal. To mention one example even respecting the functions of preservation, we have much greater difficulty in destroying new-born cats and dogs under water, than the same animals some months old, because the circulation and respiration are performed partly in consequence of other laws. It is then always a very uncertain thing to apply to an adult animal, what may have been very well observed in a very young animal. This application is not even practicable at any age, when we choose for the subjects of our experiments, animals of a very inferior order. First, many cerebral organs, with which animals of a superior order are endowed, are wanting in them. Every thing is much more simple, much less complicated, and if in consequence of this, even we obtain more simple results, we can never with the least probability, believe them equivalent to those that a similar experiment would produce, in a much more complicated organization, where the results manifest a complication of the reciprocal influence of many organs.

It must, however, be remarked, that my objections or observations against the lesions and mutilations, are particularly directed against those who, by this means, wish to learn the animal functions of the cerebellum and brain. I understand by animal functions, the mechanical aptitudes, instincts, propensities and intellectual faculties; but, so far as these are concerned, all the experimenters are yet at an enormous distance. Almost always, they confine themselves, as Haller, Ziun, Lorry, Lancerotte, Rolando, Flourens, &c. did, to an exploration of the nature and the relations of the phenomena of irritability, excitability, motion, whether spontaneous or voluntary, and sensibility. To this end, we ought to accord to them, especially M. Flourens, the merit of having devised very ingenious

and sometimes conclusive experiments. But he confines himself, so far as sensibility is concerned, like the philosophers, to generalities which are really very nearly the same in reptiles, fishes, birds, the mammalia, and man. All are excitable, all have sensibility, all have also volition; and if to eat, drink, walk, fly, leap, crawl, swim, can be included under the empire of the intellectual faculties, they all possess intelligence. Thus, it is in these points of view solely, that true and constant results, obtained from experiments performed with address and discernment, on young and inferior animals, merit our attention.

But so soon as we desire information on the mechanical aptitudes, the different propensities, instincts, and intellectual faculties, experimenters leave us in an absolute desert. It is as if these faculties and qualities did not exist, or that there does not exist any relation between them and the nervous system. They never make mention of an instinct, propensity, or determinate talent. It is known that animals have the propensity for propagation, that they love and take care of their young, that they travel, build, sing, lay up provisions, recollect places, things, and persons; that they unite together for life, &c., but all this is nothing according to the experimenters, but sensibility, or at most, modified intelligence. That such an animal is of a mild disposition, and another, savage; that such an one delights to live on the peaks of mountains, whilst another never leaves the valleys; that some construct and others do not; that some unite in marriage and others do not; that some live in society and others remain isolated; all this is not worth the trouble of searching out the cause in the animal organization, it is all explained by the unity of the brain, and, if we hesitate ever so little, even without a brain. Very well! gentlemen physiological experimenters, clear up to us a single one of these points. Before my discoveries, you did not think of this; now the materials are in your hands.

Cut, pinch, prick, remove, cause your martyred animals to live as long as you will, and show us which of those faculties continues or ceases to manifest itself! You cannot deny the existence of these qualities and faculties, since all the actions of man and animals attest them, or prove to us that it belongs only to their volition, to the direction of what you call intelligence, that the tiger has the propensities of the tiger, the sheep those of the sheep; that the male nightingale sings, and that the female and so many other species of birds do not sing; that such a man, in spite of all obstacles, excels in poetry, in a spirit for observation, in a talent for music, and that another, with all the faculties, all external encouragements, never rises above mediocrity, &c.; that such a species of animals is continually on the round of gradual perfection; that such an instinct appears and disappears at such an age, such a season; where will you show us the material conditions of these phenomena at the point of your scalpel! None of you thus far have had either the philosophy or the courage, to meet these questions; otherwise you would have soon been convinced of the insufficiency and nullity of your cruel experiments.

Let us return to M. Flourens, page 20; he says in a note: "The corpora striata are wanting in reptiles, and the optic thalami in fishes; but they all possess the tubercula quadrigemina, and consequently vision."

Thus whenever animals have a common organ, they have also the common function. If certain apparatus are wanting in reptiles and fishes, it follows that certain functions are also wanting. It is not then true that animals have all the same cerebral parts, and that they all have the same parts as man. The different parts are then destined to different functions. As this difference of composition does not only exist in different species of animals, so far as the cerebellum, brain, medulla oblongata and spinalis, corpora quadrigemina are concerned, but also for the greater or less

complicated composition of the cerebral lobes, it necessarily results, that the different parts of these lobes are destined for different functions. A singular thing this! They prove the existence of one organ for muscular contractility; another for excitation; another for the connexion of partial contractions into uniform motions, and another for volition and sensation. They wish even by carefully slicing the cerebellum, to be able to destroy the faculty of flying, or flying and walking, or at the same time flying, walking, and standing, page 40. And yet they manifest an hypocritical aversion for the plurality of the organs of the qualities and faculties of the mind, so essentially different!

I can observe to M. Flourens, that the corpora striata are never wanting in reptiles, and that it is not true, as he says, that the volume of the tubercula quadrigemina is, in all species of animals, in direct proportion with the volume of the optic nerves and the eyes.

The mole has the tubercles very large and the optic nerves and eyes very small. This proposition would be true, if the whole nervous mass of the tubercles was destined to produce the optic nerve; but the greatest part of these tubercles belong still to the continuation downwards, of the spinal marrow, and upwards to the other cerebral parts; on this account it is, that irritating them produces muscular contractions, when it extends to a certain depth. Touch only the surface of the anterior part, and no effect of irritation will ensue. Touch the bulb of the olfactory nerve, the gray band on the sides of the fourth ventricle, or the ganglion of the auditory nerve, but do not push the instrument so far as the corpus restiforme; and you will have neither contraction nor convulsion.

Our celebrated experimenter maintains, that all the parts capable of exciting contraction, have the gray substance within, and the white substance without; that an inverse disposition of these two substances

constitutes the character of the non-exciting parts, that is to say, of the cerebral lobes and the cerebellum ; that we can then judge, *a priori*, of the properties of these parts by their structure, and reciprocally of their structure by their properties.

All this proves that M. Flourens does not yet understand the true use of the two cerebral substances. There is throughout, where the nervous filaments take their rise, without regard to its locality, internally or externally, a non-fibrous gray substance. Already, in the horse for instance, we see the gray substance in the different nervous bundles of the medulla oblongata entirely on the surface. This same gray substance is apparent between the chords, especially the posterior ones, and towards the lumbar vertebræ. The gray substance is evidently more internal in the posterior parts of the tubercles, and more external in the anterior part. The cerebellum contains within its interior, the *corpus ciliare* or fringe-like body, composed of gray substance, and the hemispheres are formed by the annular protuberance, and by the crura ; all these parts have a large quantity of gray substance in their interior. And what are then the optic thalami, the corpora striata situated in the interior of the cerebral lobes, if not great masses of gray substance to give origin to diverging nervous bundles ? A little more patience and much more circumspection are necessary, before general laws can be established !

M. Flourens commences with a spite against organology ; he asks if all the sensations, judgment, memory, will, if all the faculties occupy concurrently the same seat in the cerebral organs, or rather if there is a separate seat for each of them ? "See," says he, "some experiments which fully resolve, in my opinion, this important difficulty."

This question is very improperly put ; he ought to have asked if all the instincts, all the mechanical aptitudes, the propensities, sentiments, talents, concurrently occupy the same seat in the brain.

The true fundamental qualities and faculties of the mind are the different propensities, instincts, sentiments, and the different intellectual faculties.

I have proved in the fourth volume of my large work, and I have made it sufficiently clear in this edition, that each fundamental power, essentially distinct, includes sensation, perception, memory and recollection, judgment and imagination; since these common attributes are nothing else than modifications, different degrees of each faculty. Even each propensity, each instinct, includes volition, in the acceptation that M. Flourens himself gives it in hens, pigeons, rabbits, &c. Thus so long as a single fundamental propensity or talent exists, all the general attributes also exist; so long as there exists a single atom of matter, a single plant, all the general attributes of matter and plants exist. Hence, so long as we shall not have destroyed all the seats of the fundamental powers, sensation, memory, judgment, volition remain. Let us now see the experiments of M. Flourens:

1st. "I removed from a pigeon, by careful and successive slices, all the anterior portion of the right cerebral lobe, and all the superior and middle portion of the left."

This way of experimenting supposes an organization of the brain absolutely contrary to that which really exists. Where has M. Flourens ever seen that the brain of any animal whatever is formed by layers? If he wishes to have us believe that, in his experiments, he tries to remove one faculty after another, he must attack each cerebral part, each division of fibres into bundles, at their origin in the medulla oblongata and spinalis, in the annular protuberance, optic thalami, and corpora striata; that he follows the same bundle, or this same particular organ to its ramification; and then, in returning, even to its interior commissure. This sole method of proceeding would be in conformity with the true organization of

the brain. But, to operate thus is impossible; M. Flourens has not even the idea of it, consequently all his experiments, even should he give us millions, never can have the least demonstrative value, as it respects the seat of any propensity or faculty whatever. He mutilates all the organs at once, weakens them all, extirpates them all at the same time.

"Vision became more and more enfeebled, and by little and little, as I advanced, (while he removed the layers,) and was not totally lost until the layers in the neighbourhood of the central nucleus of the two lobes were suppressed."

M. Flourens has not told us what is the central nucleus, and this central nucleus, precisely because it is the central nucleus, the origin and receptacle of all the rest; might it not be *that very limited small portion*, but sufficient to permit of the continuance of all the faculties?

"But, from the moment vision was lost, hearing was also, and with this and sight, all the intellectual and sensitive faculties."

Why does M. Flourens always insist on vision? the destruction of the brain, since, according to him, it is the seat of all sensation, and every intellectual faculty, should necessarily bring about the loss of all the senses, and all the sensitive faculties. Why then so many evasions?

2d. "From another pigeon, I removed by successive cuts, also very carefully made, the whole anterior and posterior portion of the two cerebral lobes, to within a few lines of their central nucleus."

We have the same remark to make here as before, "*to within a few lines of the central nucleus.*" How many lines of thickness has then the brain of a pigeon?

"As this ablation proceeded, the sight gradually and sensibly became enfeebled; hearing the same; all the other faculties like hearing and seeing; and when one was entirely destroyed, they all were."

Granting to M. Flourens that he has found the

measure of the successive diminution of sight and hearing. How in making his successive ablations has he also made observations on the relative diminution of the intellectual faculties of the pigeon?

3d. "Finally, on a third pigeon, I uncovered, thus to speak, and exposed the central nucleus of the two lobes, by the successive and gradual ablation of all the superior, posterior, and anterior layers.

"At each new cut, vision lost its energy; and when the animal no longer saw, he no longer heard, willed, remembered, judged, and was absolutely in the same condition with an animal entirely deprived of his lobes."

4th. "Thus, 1st., we can remove either from before, behind, above, or from the side, a certain extent of the cerebral lobes without destroying their functions. A limited portion of these lobes is then sufficient for the exercise of their functions."

I do not doubt that M. Flourens has submitted his pigeons to proofs, as ingenious as all his experiments. He must have seen, and who would not believe it, that such a pigeon still copulates, covers her eggs, feeds her young, makes excursions in the fields, makes a circuit around the pigeon house to reconnoitre the presence of an enemy, that she is still jealous, &c. Surely these propensities and instincts ought still to be fully and entirely exercised, for they are much inferior to the intellectual faculties.

"2d. As this slicing off goes on, all the functions become weak and gradually diminish in energy; and beyond certain limits, they are entirely destroyed. The cerebral lobes then concur in their totality in the full and entire exercise of their functions."

"3. Finally, when one sensation is lost, all are lost; when one faculty disappears, all disappear. There are not then different seats, neither for different faculties nor different sensations. The faculty of perceiving, judging, or willing one thing, reside in the same place as that of perceiving, willing, judging

another; and consequently this faculty, essentially one, resides in a single organ."

Let us reason like M. Flourens: We exhaust a man by bleeding: all the functions of the brain, cerebellum, *medulla oblongata*, *spinalis*, heart, lungs, stomach, &c., become enfeebled. We cut off his head, we kill him at a single blow: the functions of the brain, cerebellum, *medulla oblongata*, and *spinalis*, heart, lungs, stomach, &c., cease. Hence the faculties of sensation, thought, seeing, hearing, tasting, smelling, motion, respiring, digesting, circulating the blood, secreting bile, &c. &c., reside in one and the same organ. What! do you exclaim against this logic! ought it not to have the same privilege as that of M. Flourens, of being read, heard, opposed, and admired?

5th. "Each of the different organs of the senses have, no less, a distinct origin in the cerebral mass. We have already seen that the primordial principle of the action of the retina, and the play of the iris, is derived from the tubercula quadrigemina. In like manner, the senses of taste, smell, hearing, as well as vision, derive their particular origin from the particular eminence which gives rise to their nerves."

6th. "We can then, by destroying separately each of these particular organs, destroy separately each of the four senses which are derived from them; and we may, on the contrary, destroy, if not all these senses, at least all their result by a single blow, by the simple destruction of the central organ, where their sensations are effected and completed." But where is this central organ? As a very limited portion of the brain suffices for all the functions, and as all the parts concur in all the functions, this central organ is then each part, each little portion of the brain; thus this central point is either found throughout the brain, or is no where found.

"In the last analysis," says M. Flourens, page 122, "the cerebral lobes, cerebellum, tubercula quadri-

gemina, medulla oblongata and medulla spinalis, the nerves, all the essentially different parts of the nervous system, have all specific properties, peculiar functions, distinct effects; and, notwithstanding this wonderful diversity, as it respects properties, functions, effects, they do not the less constitute a single system."

How sublime is the mystery of ideology!

"One point of the nervous system being excited excites all the others; a point weakened enervates all; there is a community of reaction, alteration, energy. Unity is the grand principle which reigns throughout; it governs all. The nervous system forms then but a single system."

Unity is the constant dream, the *ne plus ultra* of declaiming metaphysicians. The universe is but one: millions of suns, planets, comets, are but one; the human race is but unity; different nations, the Chinese, French, Japanese, Indians, Africans, Americans, Germans, Turks, Greeks, are but one; man is one; the head, chest, belly, extremities, superior and inferior, the nervous, lymphatic, sanguineous systems, the liver, heart, intestines, &c., are but one. The senses, brain, cerebellum, tubercula quadrigemina, medulla oblongata, and spinalis, are essentially different; they have each different and specific properties, different particular functions, distinct effects. They are, according to Flourens, in a complete and fundamental independence of each other, page 127. Each of them can separately be preserved, destroyed, restored, as the organ of each is preserved, destroyed, or restored, page 102; and they are one!!!

The functions of the different parts of which the nervous system is composed, the functions of the brain, cerebellum, &c., may be destroyed and may subsist separately; the number of the senses and their functions is different in different species of animals; the functions, instincts, propensities, and intellectual faculties, are multiplied and modified, as the brain of different species of animals is more complicated and

modified ; the origins, reinforcements, ramifications of the different parts of the brain are different and separated from each other ; the intellectual faculties differ from the moral or affective faculties. One instinct, propensity, sentiment, differs from another ; the instinct of propagation differs from that of killing ; the instinct of the love of offspring, from that of travelling ; the talent of painting is not the sentiment of pride ; the talent of music, architecture, calculation, cunning, attachment, circumspection, memory of places, of persons, poetry, firmness, &c., are essentially different. These different instincts, propensities, talents exist separately, in the different species of animals, according as these animals are endowed with, or deprived of, certain cerebral parts ; they exist in different proportions in different individuals, and in the same individual, as certain parts of the brain are more or less developed than others ; the instincts and propensities of the same species are manifested at different epochs, not simultaneously, in the same individual, as certain parts of the brain arrive sooner or later at their maturity, or as certain parts undergo changes by the influence of climate, food, seasons ; in the same individual certain parts and certain functions of the brain may be changed, while others remain untouched. The same man excels involuntarily in one moral quality or intellectual faculty, and is for ever condemned to an unchanging mediocrity in another. These are undeniable facts. M. Flourens is wizard enough to reconcile them all with a single organ, with unity. You, with your good common sense, see this contradiction and absurdity : it is because you are not initiated in the art of foolish reasoning on the principles of high metaphysics.

Now I have nothing more very essential to say concerning the experiments of Flourens. It is nothing that a hen, page 124, deprived of her cerebral lobes, of all sensation, of all intelligence peculiar to the species, did not the less preserve, so soon as excited,

the faculty of running, flying, hopping, walking, with equilibrium and perfect regularity. It is nothing, again, that a duck, page 130, without cerebral lobes, without sensation, intelligence, walked, ran, jumped, flew with harmony, equilibrium, and perfect precision in all her motions; — that, page 131, a swallow, in the same condition, flew, ran, hopped with the same precision and grace as before the destruction of her sensations, volition, and intelligence. It is still much less that an *effraie* which, having lost by the ablation of its cerebellum the power of balancing and regulating its motions, presented notwithstanding, its beak and claws to its enemies, and was enabled, it is true with difficulty, to replace itself on its feet after having fallen over. Wonderful indeed is it, that that beautiful little animal, the dormouse, page 145, who, after having lost the cerebellum, sprang, seized, and bit the stick; the cat, page 144, the dog, page 145, who, after the same operation, preserved all their instincts and intelligence; the cat caught the rat that M. Flourens submitted, immediately after, to the same gentle operation, and the dog went to the chase, to furnish more ample materials for the indefatigable zeal of his master; and all this, as M. Flourens attests, during the torments of cerebellic mutilation; for without it, how would he have had a knowledge of the presence of all the instincts and intelligence of the cat and dog?

In the chapter on the application of his experiments to pathology, M. Flourens explains the difference of opinions on the seat of the soul, by the concurrence of the whole brain in all the functions: “the cerebral lobes,” says he, “can lose, either from before, behind, above, or from the side, a certain portion of their substance, without losing their functions.”

Yes; without losing the common attributes of every propensity or determinate faculty.

So long as a single organ remains, perception, sensation, recollection, memory, judgment, imagination, passion, affection, will remain. In all the experi-

ments of M. Flourens, there is not one, where the presence or loss of a single propensity or talent is proved. His assertion, then, is entirely gratuitous. Finally, if M. Flourens had not affected, in the whole of his work, to be ignorant of mine, he would have found this subject treated in the second volume, page 182 and the following; and he would have found the answer in the same volume, page 197.

"When the loss of substance exceeds a certain extent, the functions are destroyed."

No doubt: organs being destroyed, their functions are also destroyed.

"The seat of the intellectual and sensitive faculties, provided the lesion does not extend beyond certain limits, may then be attacked in almost all points, without losing its functions, whatever may be the part attacked; on the contrary, if the lesion goes beyond certain bounds, all the functions are destroyed.

"The preservation or the loss of these functions depends, then, not precisely on such or such a given point of the cerebral lobes, but upon the degree of alteration of these lobes, whatever may be the point or points attacked."

This reasoning is contradicted by a great number of pathological facts. Often, very considerable lesions of the brain have not, according to some authors, particularly according to those who hold to common attributes in any way, at least not ostensibly deranged the functions of the brain, while, frequently, very slight lesions have produced a general derangement of all the functions. I repeat it—the appreciation of cerebral lesions and their consequences requires, 1st. an exact knowledge of the organization of the brain and the reciprocal vital influence of its different parts; 2d. a detailed knowledge of the functions of the brain, of the different fundamental qualities and intellectual faculties, the instincts, propensities, and talents, &c. So long as an experimenter is not acquainted with these two indispensable conditions, all his experiments

to ascertain the *animal functions* of the brain and the different cerebral parts, are but the groping of a blind man. With this knowledge, he will acknowledge at the same time the impossibility of obtaining this end by any other means, than those which I have indicated, vol. III. page 106, 140, 141, 146, 151, 155, 160, 166, and the following, to page 216.

In all my researches the question was to discover, not the vital functions or the reciprocal vital influences of the different parts of the nervous system, but the *animal functions*, *moral qualities*, and intellectual faculties, and the seats of their organs.

"The cerebral lobes," continues M. Flourens, "effectively concur, altogether, in the exercise of their functions; it is very natural that one of their parts can supply another; that intelligence can consequently subsist or be lost by each of them."

Now I conceive that in natural or magnetic somnambulism, the solar plexus perceives and sees all the interior of the body; that the ear can be metamorphosed into an organ of smell, and the nose and the ends of the fingers, into organs of vision!

Thus then each part of the brain will be charged with all the functions; each part being placed, places there also all the faculties; each part removed, removes them all. To what good then does our study of the gradual perfection of animals tend? But, reply some, many cerebral parts, although all endowed with the same faculties, increase the energy of these faculties, which explains the different degrees of intelligence in the different species of animals.

In consequence of this supposition, the different species of animals should not differ among themselves, but by different degrees of the totality of the moral qualities and intellectual faculties, very nearly in the same way that a piece of lead of six pounds, differs from another piece weighing an ounce. But as certain species are deprived of certain faculties with which other species are endowed, it follows, that some

must be deprived of certain cerebral parts, with which others are possessed. How can we explain, on this hypothesis, the development and non-simultaneous destruction of the animal functions of the brain? How can you conceive of partial geniuses, partial idiots, partial mental alienations, precocious geniuses under one single relation, the different degrees of our different qualities and faculties, the contradiction, frequently so painful, of our qualities, the double man within us? Truly, if we consult ever so little, the most ordinary facts, the pretensions of our experimenter appear more and more absurd.

What M. Flourens says of the sympathetic nerve and solar plexus, is only the repetition of what I have said in my large work, vol. i. pages 42 and 78.

At page 236, M. Flourens explains himself, as it were from remorse of conscience, in a more reasonable manner, on what he understands by the unity of the nervous system. "But," says he "independently of this peculiar and exclusive action of each part, there is a common action for each part, that is to say, of each upon all, and of all upon each."

Thus the cerebral lobes will and perceive; it is their *peculiar action*; the suppression of these lobes weakens the energy of the whole nervous system; this is their *common action*. The proper or peculiar action of the cerebellum is coördinate with the movements of locomotion; its common action is that of influencing the energy of the whole system, &c. The proper action of the brain, cerebellum, tubercles, &c., constitutes them *distinct parts*; but the energy of each of these parts influences the energy of all the other parts, and it is this which constitutes them parts of the single system."

Without these subtile evasions; I had said, vol. i. page 77: "Each partial nervous system has its peculiar functions, although they all exercise a reciprocal influence, and are all more or less subordinate to each other."

"This being admitted," continues M. Flourens, "the whole question of the *unity* of the nervous system, is visibly reduced to the experimental estimate of the relation, according to which each distinct part of this system concurs to the common energy."

That being admitted, the whole question of the unity of the nervous system is reduced to a play upon words. I believe that I have expressed myself better when I said, vol. i. page 78; "The plurality of the organs does not exclude the unity of their action. A life takes place with many organs, and a single volition, with many instruments of voluntary motion. But if it were the reciprocal influence, which could impress on a system the character of the unity of an organ, all the parts of the animal would be an unity, since all the parts influence each other.

Since Flourens acknowledges this reciprocal influence, which I have always opposed to mutilatory experiments, *since an excited point of the nervous system excites all the others, since a weakened point enervates all the others; since there is a community of reaction, alteration, and energy: since the nervous system forms but a single system*, how can he boast so much of his isolation of mutilations and results?

I will say a word more on the physical researches of Flourens, touching the determinate or specific action of certain substances on certain parts of the brain.

His new and very ingenious experiments have two principal objects in view: the one, to confirm the speciality of the functions of the different parts of the brain, established in his other memoirs; the other, to show that the diversity of action of the different substances, is entirely the consequence of these substances acting specially by an affinitive election, on a different part of this organ.

The specific organization of the different parts of the body, and consequently the specific action of external agents, are admitted by all physicians. But has M. Flourens obtained as clear results, as well

marked and isolated by the employment of different substances, as he assures us?

"The rapidity," says he, "with which opium, belladonna, alcohol, act on small animals, hens, pigeons, rabbits, and especially small birds, allows us to multiply the experiments almost instantaneously, and to vary them in a thousand ways. The thinness of the walls of the cranium, interposes an almost transparent veil, between the observer and the phenomena."

"It was known that opium, taken in a certain dose, produces stupor, reverie, a certain intoxication of the senses, to which convulsions and derangement in the motions only ensued, when the dose was exceeded.

"It was known, that in the intoxication produced by spirituous or alcoholic liquors, the intoxication of the motions, the senses, volition, and intelligence, survive a very long time the loss of the equilibrium."

I add to this preamble of M. Flourens, that the different kinds of intoxication produced by wine, brandy, beer, &c., are different. Drunkards stagger, some forwards, some backwards, others sideways; some are dejected, others gay; some talk foolishly, others are eloquent; some give themselves up to an effusion of benevolence, others become maniacal, &c. It remains to be proved by experiment, when it is the cerebral lobes, when the cerebellum, and when the tubercles, that are specially affected.

"The watery extract of opium given to a sparrow in the dose of half a grain, produces after some time a slight lethargy. A stronger dose, one of two grains, produces as complete stupor, as the complete ablation of the cerebral lobes. In these cases, and as it is understood, in cases infinitely repeated, after the bones of the cranium are exposed, the whole region of the cerebral lobes is found exactly circumscribed by a spot of a very deep vinous red color; the posterior portion of the cranium presents its ordinary appearance. The osseous parieties being removed, the cerebral lobes appear red and gorged with blood;

and this color and this *engorgement* penetrate even to the most intimate molecules of their substance. The other cerebral parts, the tubercula quadrigemina, cerebellum, medulla oblongata, are neither changed in their color nor tissue."

"Now for the tubercula quadrigemina. A greenfinch, after having swallowed two grains and a half of the watery extract of belladonna, became, some time after, entirely blind, without any derangement of the other senses and faculties. The cranium being removed, all the region of the tubercula quadrigemina, that is to say, all the lateral and interior region of the parieties of the cranium, was found of a deep vinous red color. This experiment was frequently repeated, and always with the same result."

The cerebellum also is subject to this exclusive influence of spirituous agents.

M. Flourens caused many small birds, as sparrows, greenfinches, larks, linnets, goldfinches, &c., to swallow some drops of alcohol, not exceeding eight, and as the phenomena of intoxication manifested themselves, he laid bare the long parieties of the cranium. In all, the region of the cerebellum, and cerebellum itself, were found to the exclusion of other regions and other cerebral parts, colored with a deep red and gorged with blood.

Alterations, so strongly marked, so exactly circumscribed, so deeply impressed, the cerebral lobes by opium, the tubercles by belladonna, the cerebellum by alcohol, would certainly confirm the results of the experiments of lesion and ablation by Flourens, if both were not equally liable to doubts.

MM. Bailly, &c., and myself, have caused many small birds, sparrows, greenfinches, linnets, &c., to swallow the watery extract of belladonna, opium, and alcohol, in the doses indicated by Flourens; none of these birds have manifested an insulated symptom. All saw and heard many hours afterwards; all walked, flew, and most of them even sought food. We gradu-

ated the doses successively ; they all became more or less sick and dejected ; but they continued to see, hear, walk, and even fly ; they all endeavoured to conceal themselves. A little stronger dose of alcohol suddenly destroyed life. We decapitated the whole of them, whether they had taken the prescribed dose, or had swallowed a stronger one ; the crania laid bare in all, presented the transparent color of the brain such as it is in a state of health ! Neither the lobes, cerebellum, tubercles, nor even the bones corresponding to these parts, manifested any spot of a deep red color. Under the cerebellum only, where the heads had been separated from the trunk, there was in all an ecchymosis or *engorgement* of coagulated blood, evidently produced by the decapitation.

A remark, which throws a good deal of doubt on the experiments of M. Flourens, is, that the tubercles are situated so deeply on the base of the cranium in birds, that I cannot understand how he could remove a tubercle, and even two, and the animal should continue to stand erect, walk, fly, &c. The wound that this operation must necessarily make, is one of the most severe and dangerous, since it is necessary to extirpate the whole base of the cranium.

M. Flourens properly tells us, that these tubercles are placed at the inferior lateral region of the head, but he also tells us, that he sees them transparent when the head is fairly exposed. Now this is impossible. In the first place, the region of the cranium which corresponds to the external surface of the tubercles, is not only covered by muscles, but is very thick and spongy ; in the second place, the tubercles do not touch entirely the internal lateral parts of the cranium ; they are situated within them, exactly on the base of the cranium. Hence we have reason for suspecting, that our ideologist experimenter has a desire to regale us, after the fashion of romance writers, rather with fictions than realities, or like the transcendental philosophers, of constructing his world *a priori*.

We have given to a cock, two months old, thirty-six grains of the watery extract of opium. He ran about, flew, ate, without at all appearing sick, enjoyed all his moral and intellectual faculties; after having gone to roost, he awoke the next morning crowing and gay, and merrily joined his companions.

To a rabbit, four months old, we gave a drachm of the watery extract of belladonna; but neither sooner nor later, was the sight nor any other sense lost; his moral and intellectual faculties continued the same, as if nothing had happened to him.

How then can we justify these glorious declamations on the utility of similar experiments, on the important applications, that it is pretended can be made of them, to the physiology and pathology of man?

Let us terminate as we have commenced, by saying that in a thousand experiments of lesion and mutilation, nine hundred and ninety are either absolutely barren in results, or embarrass us, whenever they are performed by others, in interminable contradictions; that ten times at most, they serve to confirm what was already known, and that all this disposition to torment animals, in order to discover truths, will be constantly but a trifling amusement, of no consequence to science.

In order to justify my aversion to these mutilating experiments, I shall copy a passage from a very fine work of M. C. P. Ollivier, *on the spinal marrow and its diseases*, page 74.

"It results," says he "from the observations and researches recently published on the nervous system by MM. Foville and Pinel-Grandchamp, that the *corpus striata* and medullary fibres, which correspond to it preside over the motions of the leg of the opposite side; that the *optic thalamus* and its medullary fibres, that is to say, those of the posterior lobe, govern the motions of the arm; that when hemiplegia is perfect, we find an equally deep injury of both of these parts; and when it affects the arm and leg unequally,

it is because the alteration is not carried to the same degree in the optic thalamus and corpora striata; that finally, the cerebellum is the seat of sensibility; opinions, which accord with what experiments have demonstrated respecting the functions of the spinal marrow."

M. Flourens has frequently removed the lobes with the *optic thalami* and the corpora striata, and never has he seen paralysis ensue.

"This function of the cerebellum, (that is to say, that of being the centre of sensibility,) relative to the cerebro-spinal system, is not that which M. Flourens has pointed out. He believes himself justified in thinking, from his own experiments, that the cerebellum presides over the regularity of the motions of progression of the animal. The integrity of this organ must be perfect, says he, in order that the animal may find the necessary equilibrium in his locomotion. I do not believe that this conclusion, derived from experiments made solely on birds, can be applicable to all the vertebrated animals; for, the cerebellum is wanting in many of those in which the motions are not less well ordered, as frogs, toads, &c."

On this last point, M. Ollivier has been mistaken, as well as M. Desmoulins. But he might have added that Rolando makes the cerebellum the organ of the motions of locomotion, whilst M. Flourens only makes it the regulator or balancer of these motions; that the adder, which is not less agile than the eel, has a very little cerebellum, whilst the eel has a very large one.

"From recent experiments, M. Majendie regards the integrity of the cerebellum, as necessary to the performance of forward motions; for, he has observed that a moderately severe wound of this organ renders progression forwards impossible, and that it most frequently developes, on the contrary, a combination of motions which resemble the action of going backwards."

Another experimenter has maintained, that the cer-

ebellum was the cause of backward motions, and the brain, forward ones! Tell me, if these contradictory reveries ought not to disgust us entirely with this kind of researches?

Let us cite another passage of M. Ollivier, page 71.

"We have seen that the threads of the anterior roots, of the spinal marrow, are remarkably inferior in size to those of the posterior roots. This material difference is also connected with a difference of functions, which has been demonstrated by the experiments of MM. Charles Bell and Majendie. It results from these, that the posterior roots are for sensation, and the anterior, for motion. Nevertheless, adds very prudently M. Ollivier, it does not appear that each of these functions is exclusively given to each order of roots; for, when we excite the nerves of sensation alone, that is to say, the posterior roots, contractions are produced in the muscles to which these nerves are distributed, although generally they are much stronger and more complete, when the excitation is applied directly to the anterior nerves."

This want of complete isolation of the two functions in question, seems to me to depend on the circumstance that the two gray bundles of each lateral half of the marrow, are entirely confounded in each other at their point of contact; in another point of view, the very intimate union which takes place between the two roots below the spinal projection, must also influence their respective properties, and contribute further to unite them, if this expression is allowable, and combine them together."

M. Majendie expresses himself in a more decided manner, in his memoir on some recent discoveries relative to the functions of the nervous system, page 10.

"I have proved," says he, "by direct experiments, that these distinct roots, (anterior and posterior,) have also functions entirely distinct. The anterior are destined for motion, the posterior for sensation. If we cut off the first, the animal loses all motion, but

he preserves his sensibility untouched ; and, *vice versá*, if we cut the second, sensibility is lost, but the animal preserves his power of motion."

"I have recently had an opportunity to confirm on man, these different functions of the roots and nerves."

An individual had lost the motion of his arms for many years ; he still preserved a lively sensibility in them. He died, and on the examination of his body, we found the posterior roots in their state of integrity, whilst the anterior ones, which were evidently changed, had lost their medullary substance, and were reduced to their membranous envelope.

Although I am a little suspicious of this autopsy, other observations present themselves in support of the proposition of M. Majendie. M. Ollivier, page 334, cites an observation of M. Royer Collard, where the softening of the anterior part of the spinal marrow coincided with a paralysis of the inferior extremities. It is to be observed, that the motion of the superior extremities remained, although all the anterior part of the spinal marrow was converted into a sort of pulp. The paralyzed extremities had preserved their sensibility ; but observations are not wanting, where the contrary takes place. In general, it is the same with diseases, compressions, lesions, inflammations, &c. of the spinal marrow, as with mutilations of the different parts of the nervous system. Almost always, the accidents are confounded. Often the part above the place where the brachial nerves arise, is diseased, and there is neither paralysis nor convulsions except in the inferior extremities. In a man of twenty-one years of age, I have found the anterior face of the cervical and lumbar marrow exceedingly inflamed. He had had convulsive shocks in the arms and thighs, hiccough, vomiting, an extreme sensibility of the eyes, an insupportable heat in the chest, throat, palate, and tongue ; with convulsive motions and sensibility at the same time ; in a word, physicians will never be able to arrive, by the most exact observation of symptoms, to the knowledge of the seat of disease.

Professor Burdach,* before the year 1819, page 363, had already performed experiments, to determine the difference between the functions of the anterior and posterior chords of the spinal marrow. He and professor Baer cut the anterior roots of the nerve of the right thigh of a frog; it at once lost all turgescence, became flaccid, insensible, and motionless. The animal hopped with the left hind foot. Then they cut the posterior roots of the nerve of the left thigh, and instantly the left thigh was paralyzed like the right. The frog crawled with the fore feet, and dragged the dead hind feet as a foreign body. They charged with the galvanic pile the spinal marrow positively, and the thighs negatively; there were convulsions in both thighs, without any observable difference in them. M. Burdach observes, that it is necessary to make new experiments as well on the anterior and posterior roots of the nerves, as on the anterior and posterior chords. He is induced to believe that the posterior chords are more irritable than the anterior. Already in 1815, Gross (in Thomson's *Annals of Philosophy*; February,) had declared that the anterior chords were the organs of sensation, the posterior, the organs of motion, &c. &c.

In my large work, vol. i. page 68, I have inquired if it was necessary to make any difference between the nerves of the sensations, and those of the motions?

This is my answer: Erasistratus had made this distinction; Torrigiano had rejected it, because, generally, the same nerve is the seat of sensation and motion. We add to this that the pathological phenomenon, in which, sometimes motion, sometimes sensation, is lost, takes place in those parts which receive nerves of voluntary motion only. We cannot demonstrate this difference by any method, neither in the different bundles of nerves at their origin, nor in their external course. It is besides certain, that all

* Vom Bau und Leben des Gehirns. Leipzig, 1819.

the nerves of voluntary motion can also excite sensations in the whole surface of the body, and particularly at the extremities of the fingers, where they produce the sense of touch. Yet, why do the nerves of the senses have particular nerves for their special functions, and others for motion? Would it be sufficient, in order to explain the pathological phenomena, to suppose that they come from a simple modification, from a varied alteration of the same nerves?

In this uncertainty we have thought, that the posterior roots are stronger than the anterior, since we require more strength to straighten up and resist a burden, than to bend and stoop. The extension of the body even which takes place after death, seems to indicate this preponderance of the posterior nerves.

The idea has occurred to me, that perhaps the origin of the nerves of motion and of those of the senses, might throw some light on this point. But still here there is nothing permanent. The nerves of motion and those of the senses have their roots indifferently, sometimes in the posterior, and sometimes in the anterior face. The brain even and the cerebellum are the reinforced continuation, as well of the anterior chords as of the posterior and lateral ones. Thus the questions, viz., whether there are nerves solely belonging to sensation, and nerves solely destined for motion; whether these two functions are conjoined in the same nerves; whether in the same nervous chords there are filaments of sensation and of motion; whether, according to Scope, the ganglions belong solely to the posterior bundles; whether the posterior roots rather are destined for the sensations, and the anterior ones for the motions, or whether the inverse takes place; these questions, I say, are as yet, beyond the reach of our knowledge. The uncertainty becomes still greater, if it is true, that all the nerves evidently destined for motion, or the third, fifth, and sixth pairs, derive their filaments from the anterior and posterior continuation of the spinal marrow.

Comparative Anatomy of the Brain in the four Classes of Vertebrated Animals; vol. i. by E. R. A. Serres, &c. Paris, 1824.

Most decidedly the transcendental philosophy of Germany has taken possession of the heads of our French philosophers. MM. Berard, Jourdan, Flourens, Serres, &c., have constituted themselves proselytes of MM. Ocken, Carus, Rudolphi, Burdach, &c.

To hear these gentlemen, every thing in the nervous system is homogeneous, all is unity; the white fibrous substance gives origin to the non-fibrous substance; the nerves are formed from the circumference to the centre, and not from the centre to the circumference, &c. Before these physiologists, every thing was confusion, uncertainty, and error. Malpighi, Ruisch, Albinus, Haller, de Graf, Sæmmerring, Arsaky, Harvey, &c., *have all interpreted nature in an inverse sense; they have always supposed in her a course directly opposite to that which she pursues; ought we then to be astonished if her laws have been misunderstood?*

M. Serres proposes to himself, to unite in one body of doctrine all our acquired knowledge on the anatomy, physiology and pathology of the nervous system. The propositions announced, so piquant by their paradoxical appearance, constitute the object of his numerous researches. We shall follow him step by step, at least so far as his principles are opposed to ours.

Homogeneity, Unity of the Nervous System.

"Follow," says M. Serres, page 17, "the human mind and nature in the physical and moral order: you will every where see man who separates and divides in his thought, and nature which unites in its action."

The philosophy of nature, and M. Serres, do quite the contrary of that which nature does. She operates

entirely in individualities ; each different effect is the result of a different cause. The transcendental philosophers operate by abstractions ; "they form from all their experiments one single fact, and from all truths, one sole and single truth. At the aspect of the varied forms which organized beings present, at the aspect of the innumerable modifications which their organs present, the mind is arrested, and overwhelmed under the weight of so many details ; and after long years of meditation, it proclaims the unity of organic composition," page 21. After this, is it man or nature which divides and unites ?

Page 54, M. Serres says without any preceding proof : " Thus then the brain of all classes of animals is brought back to an identity of composition, which does not permit us to mistake the homogeneity of its elements ; but by the progress of its development, this identity is effaced ; dissimilarities are established either in all or only in some parts. The higher we ascend in the superior animals, the more numerous these dissimilarities become, the more strongly are they pronounced ; the farther we descend in the lower animals, the more do they diminish and become indistinct ; the more does the brain retain its early physiognomy." This identity can only efface the forms, since, according to M. Serres, the elements are always the same. For their elements changing form and position, each subsisting in each class of new transformations, the whole of the brain is so far modified as to be no longer recognised from one class to the other. This is of no consequence to M. Serres ; there is no less a perfect unity.

After having spoken of the modifications that the different cerebral parts undergo in fishes, reptiles, birds, and the mammalia, he applies his logic to the cerebral hemispheres. "Certainly," says he, page 61, "if any one should wish, at first, to reduce the cerebral hemispheres of monkeys, to the cerebral lobes of fishes, he would fail in his undertaking. He would

perceive, on the one part, very simple organs, on the other, very complicated ones, having no external relation in their form, configuration, or structure. All the characters, which assist anatomists in distinguishing the homogeneity of organs, being absent, we should be induced to believe, that these parts are entirely dissimilar, and have no analogy with each other."

"But let us go very far back to the uterine life of the mammalia; we shall first perceive the cerebral hemispheres rolled as in fishes, into two vesicles isolated from each other. Later, we shall see them affect the configuration of the cerebral hemispheres of reptiles; later still, they will present to us the forms of those of birds; finally, they will acquire at the epoch of birth, and sometimes later, the permanent forms which the adult in mammalia presents."

"Suppose we reduce the whole of all these evolutions to four periods; we shall see at the first period, the cerebral lobes of fishes arise, and their *homogeneity* in all the classes; the second will give us the hemispheres of reptiles, the third will produce those of birds, and the fourth, finally, will give rise to the complicated hemispheres of the mammalia."

To this analytical demonstration, M. Serres joins that by synthesis:

"Take a monkey at birth: you will find in his brain all the parts, which distinguish the mammalia from the other vertebrated animals. Go back to the uterine life, you will first see certain lobes of the cerebral hemispheres disappear, also the hemispheres of the cerebellum, the corpus callosum and annular protuberance. What remains corresponds to the brain of birds. Examine an embryo younger still; the fornix disappears, the hemispheres contract posteriorly, the tubercula quadrigemina are exposed on the superior surface of the brain; we have then two geminal lobes as in reptiles, of which this encephalic mass reproduces the type. Finally, go farther back still in the uterine life, you will find the cerebral mass formed by

lobes placed symmetrically in a right line, the one by the side of the other; you will find a cerebellum formed either of two parts, the one right, the other left, or, of a delicate layer partly covering the fourth ventricle; you have, finally, the whole of the brain of fishes. Thus in ascending in the animal scale, from fishes to monkeys, you observe the brain gradually becoming more complicated, as in descending from adult mammalia to their different epochs of fœtal formation, you will perceive this organ successively become more simple. You come by these two courses to the same result, *to the unity of their formation and composition.*"

We must either refer this inference to a pure declamation that M. Serres wishes to partake with the transcendental philosophers of Germany, or the condition of writers is indeed melancholy. In proving the plurality of cerebral organs, I have based my inferences on the same facts which have induced M. Serres to decide on the unity of formation and composition. Let us admit, what is not true, and which M. Serres has very poorly copied from the Germans, that the brains of mammalia in the early periods of uterine life, resemble the brains of fishes, reptiles, and birds; it is not the less true that the brains of the mammalia are, later, according as the species differ, more or less complex; that in one species such a particular part is wanting, which is possessed by another. "In ascending from the inferior to the superior classes, we see this organ, at first so simple, approach gradually, in reptiles and birds, to that admirable organization which we know it possesses in the mammalia; and to that structure, more admirable still, which man presents." From this very language of M. Serres, how can he establish as an axiom that "the brain of vertebrated animals is constructed on a uniform type, and *with the same elements?*"

Are the brains of a blind or deaf animal, or those deprived of the sense of smell, composed of the same elements, as those of animals that see, hear, and smell?

And can the brains of the rabbit, fox, tiger and elephant, of the pigeon and falcon, be composed of the same elements? Yes; the fibrous, and non-fibrous substance, the cerebellum, tubercles, hemispheres, &c., &c., are constantly found; but first, these parts are more or less simple, more or less complicated; in the second place, it is an absolutely gratuitous supposition, that the constituent parts of analogous organs, are identical in the different species of animals. All trees have ligneous fibres, and a bark, between which is deposited the cambium. Are these ligneous fibres, these barks, cambiums, on this account, homogeneous? All animals have a stomach, but we have not yet had a physiologist so silly, as to maintain that the stomach, which digests only vegetables, is identical with the stomach which digests only flesh. We possess the five senses, in common with the greatest number of mammalia; but is our taste identical with that of the goat, that feeds upon euphorbium with avidity? Many emanations which are powerful excitants to certain animals, are unperceived by us, &c. I have already so frequently refuted the identity and unity of the different parts of the nervous system,* that I feel ashamed to be obliged to tell my readers, that, at this very time, partisans of this absurd fiction still exist.

"The nervous substance," say they, *Archives Generales de Medicine*, Vol. IV., January, 1824, page 27, "is every where identical. It is nothing more than the rectilinear disposition of uniform globules. It has every where the same properties, those of sensation and motion. The diversity of its functions is merely apparent. This diversity results from a different arrangement of the same homogeneous matter. On this account, the organs the most varied as to form and position, can have the same functions. There is

* See in the first volume of my large work, my treatise on the difference of the nerves and the functions of the senses,

no sensible difference in the globules of the olfactory nerve, and those of the optic, of the nerves of the anterior, and those of the posterior face of the spinal marrow."

Thus, since there is no sensible difference in the pretended globules of the different nerves, we must conclude that there is no real difference! By similar reasoning, the whole universe has been made to consist of identical molecules, the different arrangement of which constitutes the essence of all organic and inorganic beings, living and dead; a very convenient hypothesis for minds that are easily satisfied!

"In the mammalia," says M. Serres, page 9, "all the parts of the brain are very nearly the repetition of each other. Families induce some changes in their proportions and relations; but with very little attention, it is easy to restore them to the classical type, of which they are but a slight modification. In birds, this organ is still more permanent than in mammalia; all the families of this class are remarkable for the identical composition of their brain. From the smallest to the largest, it is but the repetition of the same elements, preserving always the same forms and the same connexions."

Let us dwell a moment on these passages, as remarkable for their falsity, as their boldness. Without again becoming tedious in relation to the different elements which must necessarily enter into the composition of the analogous parts of the brains of the different species of animals, let us compare only their brains, as to the forms which come under the observation of the senses, and under the relation of the parts of which the hemispheres of the cerebellum and brain are composed. They pretend to find a striking resemblance between the brain of the ourang outang, and that of man. But the difference of their volume is, first, as five to one; their convolutions differ greatly, as to number and structure; the anterior lobes, especially, are conically constructed, flattened above, exca-

vated below, &c.; the difference is much more sensible still in the other species of monkeys. Even from one species of monkey to another, you will perceive the hemispheres differing, as to the number and structure of the convolutions. Can we call the entire absence of essential parts, a simple modification, or a modification only of the proportions of the different cerebral parts? Now, compare the brains of most of the mammalia, either with each other, or with that of man, and each species will present essential differences. Compare the middle lobes of the frugivorous, with those of the carnivorous animals; the brain of the hare with that of the cat, the dog with the sheep, the goat with the hog, the mole with the lemming, the brain of the guinea-pig with that of the weasel, the shrew-mouse with that of the rat. Do not forget at the same time, that all these differences are in direct relation with the difference in the instincts and faculties of these animals, and thus the path will be traced, by which you will be enabled to discover the functions of the different cerebral parts. Without doubt, in all brains the fundamental parts have received the same names; but have the oak and the ivy the same organization, because both grow from a seed, because both have a stalk which ramifies, has leaves, flowers, and fruit?

Cast the same investigating glance on the brains of the different species of birds. Compare the brain of the cock with that of the eagle, the brain of the stork with that of the swan, the sparrow with the goldfinch, the brain of the gros-bec with that of the cardinal, the pigeon with that of the cuckoo, the brain of the owl with that of the parrot; think, at the same time, of the difference and modifications of their instincts, and decide, if it would ever be pardonable to admit homogeneity of elements and composition.

You yourselves see; you delineate these differences; you admit the great difference that exists in the brains of reptiles and fishes. For what purpose, to what

end, are all these differences? Are they an idle freak of nature, or are they material conditions of the diversity of their faculties? But all this language of nature, so clear, so precise, is not understood by the physiologist, infatuated with the idea of centralization, and of the unity of conformation: by those who pride themselves in a high and elevated conception, in regarding the cerebellum as a reversed brain, the brain as a repetition of the spinal marrow, and the most distinct parts of the brain, as the simple repetition of the same homogeneous parts; by physiologists, who seem to be ignorant, that, when nature repeats an apparatus, she repeats also the function, and that when she has for an object functions essentially distinct, she creates also essentially distinct apparatus.

Is it not a pitiful caprice of our physiologists, to make such uncertain and minute researches on thousands of brains of reptiles, of fishes, &c., of the habits of which they have hardly the most superficial knowledge, — to tell, with more or less plausibility, what part is the olfactory nerve, the optic, auditory nerve, cerebellum, brain, tubercles, &c.?

Is it not ridiculous to treat these matters, which for the most part escape our senses, and on which the most experienced anatomists are not agreed, as objects of the highest importance, while they never dare to direct their attention, either to the difference of the cerebral organization in animals analogous to man, or towards the diversity of the mechanical aptitudes, instincts, propensities, and faculties, which constantly attend this variety of organization. The physiologist is always away from the question, when he reasons as a metaphysician; there is but one correct philosophy on the moral and intellectual nature of man and animals, which can safely guide him in his researches and inductions.

Let us return to the homogeneity of all the parts of the nervous system, and examine if each part is fit for all the functions; or, in other words, if the function

of one nerve, or one part, can be transferred to every other nerve, or every other part of the cerebral mass?

The ideas of the centralization, unity, homogeneity of the nervous system, are, as I have already said, reveries of the transcendental philosophy of Germany. They have been very warmly received; 1st, because they were thought proper to combat the plurality of the cerebral organs, and 2d, because they favored the juggleries of animal magnetism.

Here again we have a proof of the power of induction of M. Serres: as a conclusion he repeats, page 567:

"The cerebro-spinal axis forms a single organ; the two substances which compose it, are continued from the vertebral column into the cranium, in all the vertebrated animals. This continuation is not a simple relation of contiguity. The medullary bundles which compose both parts, correspond in an admirable manner, from the brain to the superior part of the spinal marrow, or from this to the brain. This correspondence serves to complete all the proofs, that we have given, of the identity of the principal elements of the brain in the four classes of animals.

If you consider the pyramids, you observe that they are in direct relation with the cerebral hemispheres in all classes of animals. Whatever is the difference in form and size of the hemispheres, they are always in connexion with the anterior bundle of the spinal marrow, as may be seen in fishes, reptiles, birds, and the mammalia.

If you observe the cerebellum, you will constantly perceive its relations with the posterior chord of the spinal marrow in the mammalia, birds, reptiles, and fishes.

If, finally, you examine the tubercula quadrigemina or the optic lobes, you can constantly follow their connexions with the middle bundles of the spinal marrow or the *corpora olivaria*.

"This last relation is very important to observe in

birds, fishes, reptiles, and the mammalia, because it completes all we have said, on the analogies of these fundamental parts of the brain in all the classes of vertebrated animals."

First, M. Serres confounds the middle bundles with the corpora olivaria. These bundles exist in embryos before the appearance of the corpora olivaria; they exist in fishes, birds, the amphibia, which are notwithstanding deprived of corpora olivaria. Then what relation can parts, that do not exist, have with the brain or with the determination of cerebral parts, in fishes, birds, reptiles, and the amphibia?

Finally, if all these connexions prove the unity of the organ of the cerebro-spinal axis, every animal and all its parts will constitute but a single organ, since there is a connexion between them all. How can M. Serres and the partisans of this unity, conceive of the identity of the spinal marrow, medulla oblongata, brain, and cerebellum, seeing that there is always an augmentation of the two substances in these different parts, and that their functions are evidently and essentially different?

At page 2d of his preliminary discourse, M. Serres finds the idea of M. Dumeril sublime and classical. This philosopher said that the cranium of animals was but a vertebra, and the brain but the spinal marrow swollen out. Later, the cerebellum has been transformed into a reversed brain. *O tempora, O professores!*

Can the Function of one Sense or Organ, be transferred to another Sense or Organ?

After speaking of the different development of the different cerebral parts, in the fishes, reptiles, birds, and mammifera, Serres, following Carus, says, p. lxxxii; "Finally we shall find, that the faculties may be transferred from one element which is subordinate, to an adjacent element which then becomes the domi-

nant one." In the *Archives générales de Médecine*, T. II. Oct. 1823, p. 235, is the following passage. "It is very probable that in somnambulism, some nerves quit their proper sphere of action, and produce sensations similar to those, produced by the proper sensorial nerves in their sound and natural state."

Carus had already said, p. 305, with a thousand other credulous and metaphysical German physiologists, that the whole cerebral mass is homogeneous; that nothing prevents the functions of one part from being transferred to another, and that it would not be contradictory to any thing we already know, if, after the entire destruction of the hemispheres, the intellectual faculties, or consciousness, should still remain. On this supposition, the spinal marrow and nerves, the nerves of the senses, the plexuses and ganglions of the sympathetic nerve, may all, indiscriminately and reciprocally exercise any function whatever, of the nervous system. Nothing hinders an ox or a horse, from being equal in understanding, at least, at the moment of the magnetic influence, to Plato, Locke, or Kant, since the identical, and preponderant nervous mass of their senses, spinal marrow and sympathetic nerve, will amply supply the deficiency occasioned by the much smaller mass of their brains.

Do the French deserve the reproach of disdaining the productions of the German soil! We refute the calumny, by pointing to the history of animal magnetism, of the transcendental philosophy, of absolute spiritualism, of the centralization of the human brain, and of the homogeneousness and unity of all the parts of the nervous system. Can more sublime and generous concessions be required, to impede the progress of positive knowledge and check all spirit of observation?

"One of the physical laws of organic matter," says Serres, p. 407, is, "that dissimilar organs may discharge the same function. Thus, the skin and lungs concur in respiration; and this function is performed by

the gills of fishes, and the tracheæ of insects, — organs exceedingly different from the lungs of mammifera and birds. The skin and urinary organs may reciprocally perform each others functions. Locomotion may be transferred from the limbs, by which it is performed in mammifera and birds, to the coccygeal apparatus which occurs in the case of fishes, as has been happily observed by the author of philosophical anatomy, (Geoffrey St. Hilaire.) The sense of smell, Professor Dumeril has ingeniously observed, may be transferred from one nerve to another, and according to the observations of Scarpa, Carus, Jacobson, and Treviranus, the sense of hearing may, in part, be entrusted to the fifth pair. My own researches have proved, that the chrysochloris, (*Talpa Asiatica*, L.), the rat-mole, (*Mus maritimus*), the zemni, (*Mus typhlus*, L.), and the proteus, see by means of a different nerve from the optic nerve. Why may not the ganglion of the fifth pair, in the invertebral animals, be the seat and point of reunion of their different sensations? Had not Cuvier such facts in view, when he promulgated his general law of the action of the nervous system?"

On page 385, Serres mentions this general law of Cuvier, viz., the diversity of the functions of nerves depends more on the different organization of the parts to which they are distributed, than on their own nature.

Serres, then, has forgotten — what he might have read, in my chapter on the difference of the nerves, T. I., p. 127, 4to. — that Cuvier, in his *Anatomie comparée*, p. 192, has disavowed this general law, laid down, p. 95. There he says; "Analogous parts invariably receive their nerves from the same pair, in all animals, whatever may be the position of these parts, or however much this pair may be obliged to deviate from a straight course, in order to reach them. Analogous nerves always have a similar distribution; they always go to the same parts. Even the small pairs,

whose distribution is more circumscribed, or whose place may be more easily supplied by the adjacent pairs, as the fourth and sixth, preserve their existence and use."

As Serres is resolutely bent on giving to Baron Cuvier, the honor of a general law for the action of the nervous system, which will he choose, that on page 95, or the subsequent more precise and circumstantial one, on page 192? Being well aware, that such a paradoxical notion needs to be well supported by facts, he cites his own researches on the moles chrysochloris, rat-mole, zemui, and proteus, which showed that these animals see by a different nerve from the optic. I have never dissected the chrysochloris, rat-mole, zemni, nor proteus; but I have examined the organ of vision in the mole, and I have found the optic nerve exceedingly small, it is true, as in all the species of rats, mice, and other small mammifera. M. Bailly has subsequently confirmed my observation, and demonstrated it to Geoffrey St. Hilaire and Cuvier. I conclude it is the same with the other animals, where the investigation is a little difficult, on account of the smallness of their eyes, and visual nerves. On page 129, T. I, 4to., I have refuted this same error, committed by Treviranus, both in regard to the auditory nerve, which he says is simply a branch of the fifth pair, and to the optic nerve, the origin of which he derives from the same root, as that of the muzzle. What confidence can be placed in anatomists, who, like Treviranus, *Biologie der Lebenden Natur*, B. 1, page 459, maintain that the cerebral convolutions are wanting in many species of the dog family; that mammifera have no pyramidal bodies, and that their cerebellum, consisting almost entirely of the vermiform process, contains no nodule of gray substance, or ganglion? I shall have occasion to prove, that Serres is also very often deceived about things, far more obvious than the optic nerve of the mole, &c. When such gross mistakes are made in regard to large ani-

mals and man, how can we confide in researches infinitely more delicate, particularly when their results are in contradiction to the constant laws of nature? If these things were true, where would be the uniform type, so much vaunted on all other occasions?

The opinion expressed by Dumeril, *Memoire sur l'Odorat des Poissons*, lu à l'Institut en 1808, not respecting the smell of fishes, as Serres pretends, but their taste, which he banishes from the mouth and transfers to the organ of smell, I have also combated, T. I., p. 154, "but," says Serres, "by assertionis, that can have no weight with men, who evince no partiality in their inquiries after truth." Let us see these assertions. "Supposing, with Dumeril, that fishes have no hypoglossal nerve, this, then, can serve only for motion, and the branches of the fifth pair, which they possess, are ramified in the different papillæ of their tongue and mouth. According to Dumeril, the constant pressure of the water blunts the taste of fishes; but why does not this same pressure also blunt their smell? Why, notwithstanding our habit of walking, does the sole of our feet preserve such an acute sensibility? Besides, the tongue of most fishes is moveable, and is furnished anteriorly with a fine, supple skin. It would be idle to spend more time in refuting an opinion, which charges nature with having created a special apparatus for nothing at all."

Here, too, are some more assertions from my *Treatise on the Difference of the Nerves*, which tend to destroy the opinion of Dumeril, Serres, Treviranus, &c.

A difference not only exists in the external, but a very distinct one, too, in the internal apparatus of the nerves. Their point of departure, their number of ganglions of reinforcement, their consistence, color, commissures, all their conditions, in fact, vary in different nerves. They are developed at different epochs. In man, the spinal marrow, the nerves of the muscles of the eye, and the trigemini are firm

and fibrous, and the olfactory nerve is large, and presents distinct filaments, while the brain and cerebellum are yet pulpy, and the optic and acoustic nerves seem to be entirely composed of gray substance. There is a striking difference between the soft, red, and whitish nerves of the sympathetic system, and the hard, white nerves of the spinal marrow. On the other hand, the delicate, nervous fibres of the brain and cerebellum are distinguished from the spinal nerves, by their whiteness, as well as softness. All the nerves differ in their configuration. The nerves of sense are not at all similar in point of color, consistency, form, and texture. Oftentimes, different filaments of the same nerve even, are visibly unlike. Not only different nerves, but the filaments of the same nerve, may issue from different ganglions, situated in different places. All these peculiarities remain the same in the same nerves; and, therefore, the cause must be a primitive difference of internal structure, which is essentially necessary to a diversity of functions. This is the reason why it seemed so natural to Cuvier to conclude, "that the nerves are not entirely similar, and do not, for example, convey absolutely the same fluid as the arteries do; but there is, in the structure of each, and in their mode of action, some peculiarity relative to the functions, and to the nature of the organ which they animate." Page 192.

The proofs derived from anatomical principles, of a difference in the nerves, are strengthened by others, drawn from physiological principles. It is admitted, that the external apparatus convey different irritations and impressions to the nerves; but if all the nerves are of the same nature, how happens it, that these different impressions from their peripheric extremities, are transmitted to the brain without alteration? Ought not the impressions of the optic nerve to be transmitted differently from those of the auditory or olfactory nerve? Supposing the mode of communication to be the same, but only stronger in one sense,

and weaker in another ; then, as Sømmerring has well observed, they would be only stronger or weaker, and consequently, would not be essentially different. A difference in the mode of propagation, therefore, necessarily requires one in the internal structure of the nerves. The same rule must apply to all the nerves, whatever may be their functions, since they are designed to propagate determinate, or specific impressions. The internal structure of the nerves must differ, when their action on the different parts differs. The secretion of the saliva of the gastric juice, of the bile, of the semen, of the tears, and the different kinds of irritability in all the parts, absolutely require different actions, and consequently different nerves.

Hence it is, that the nerves of the senses are able to perform their special functions, in consequence of inward irritations only, and without the concurrence of the external world. Our sensations in dreaming, are the same as those produced by external objects. A man who has lost his sight, dreams that he sees ; a pain is imagined to be felt in an amputated limb ; the flow of blood to the eye, makes us see sparks and brilliant objects ; a flow of blood to the ears gives rise to a singing and buzzing, and the same flow to the surface of the skin, makes us dream of being in the warm bath ; a blow on the eye, and the contact of two different metals, one of which is applied upon the upper lip and the other placed under the tongue, occasion light ; and finally, illusions of the senses in disease, are all derived from internal causes. Why, then, do you admit one class of nerves for motion, and another for sensation ?

Many nerves, commonly regarded as simple, originate by filaments arising from different points ; the fifth pair, for instance, arises from three different places, having three entirely different main roots. The olfactory and optic nerves, in mammifera, receive their filaments in their course, be it more or less long. The third pair arises in part in the blackish substance

in the bifurcation of the peduncles of the brain, and in part, in the gray substance lying over the bundles that are situated a little more externally. Thus, all the nerves arise from a greater or less extent of surface, and this apparently explains the numerous modifications, that the same nerve may receive. We see more than one color, and hear more than one sound; it is not a certain color or ray only, that we see, nor a certain sound only, that we hear. In one animal, the nervous filaments are sensible to certain odoriferous particles; in another, they are designed to receive others.

Why should a nerve invariably have the same origin, the same course, and generally, the same organization? Why does not an external apparatus receive its nervous filaments, sometimes from one adjacent nervous branch, and sometimes from another? Why this exactness, this minute adherence of nature to its usual ways? Why such a number of apparatus, if nature, which is always economical, could have attained its object with only one? Why is a whole sense annihilated, when the optic or auditory nerve is destroyed? Could not nature have prevented this loss by numerous communications of different nervous filaments, in the same way, that it remedies the effects of an obstacle in the usual course of the circulation of the blood, by anastomoses of vessels? If such assertions as these have no weight against the homogeneousness and unity of the nervous system, with men who evince no partiality in their inquiries after truth, I should be tempted to believe that M. Serres' impartiality expects more profitable returns from the incense which he flings out, hit or miss, to his guardian idols.

The localization of certain cerebral parts, the tubercula quadrigemina, for instance, is very justly used by Serres, as a ground for determining other parts of the encephalon. But how could any part whatever, or its function be determined, if this localization were not constant; if a certain cerebral part could occupy,

sometimes this place, and sometimes that, or if all the parts enjoyed indifferently, the same functions? Where would be the use of determining parts from their localization?

Another Discussion of the Question, whether the Non-fibrous Substance of the Nervous System gives Origin to the White, Fibrous Substance.

The non-fibrous gray substance is not first formed, and cannot give origin to the fibrous white substance.

The nervous system, as well as the whole organism, is not formed from the centre to the periphery, but from the periphery to the centre.

These are the two propositions to which Serres recurs on almost every page of his work. They are there so blended and interlaced with each other, that it is very difficult to isolate them. However, I shall try to render the matter a little clearer, and treat of each separately, as far as possible.

"The hypothesis of Gall and Spurzheim," says Serres, "is so blended with their facts, as to be incorporated with them, and we know not where it would have led us, had not Cuvier, in his memorable Report to the Academy of Sciences, paralyzed its effects." Page xlviii.

This memorable report, as well as all the writings of my opponents, will always be the most precious voucher I can have, of how far in the rear, the anatomical and physiological knowledge of the nervous system was at that time, and how much, in this respect, science is indebted to me! Without reminding M. Serres, that almost every point that was disputed in that report, has since been generally acknowledged and received by Cuvier himself; let me ask him to read in that memorable report, one of the eighteen propositions acknowledged to be true by the Committee, expressed in the following terms:

"That the gray substance is the origin and matrix of all the nervous fibres, and by its means, they are reinforced and multiplied." Considering this discovery a little too good for us to make, they tried by all manner of sophistry, to prove that it expressed a generally received opinion; but we refuted this position in our reply to the report, p. 70, &c.

Serres continues: "Gall's hypothesis is founded on the idea of the central development of the nervous system. It supposes, that the spinal marrow and encephalon, are formed from the centre to the circumference. The gray matter in the cerebro-spinal axis is considered to exist previously to the white matter at the periphery; to the nerves implanted in it; to the intervertebral ganglions, still more excentric; and finally, to the nerves that, from these ganglions, radiate to every part of the animal. This opinion, therefore, depends on the common notions relative to the development of this system."

"But if its formation is excentric; if all these parts follow an inverse order in their appearance; if the nerves are first formed in the organs; if, later still, the intervertebral ganglions are developed before the spinal marrow is in existence; and if this axis is itself developed from the circumference to the centre, we see that this hypothesis is utterly opposed to facts."

"We see that the intervertebral ganglions do not furnish the substance of the nerves which radiate from them, since these nerves exist before they do."

"We see that the spinal matter is not, and cannot furnish the substance of the chords that are implanted in it, since these chords do not primitively communicate with it, and frequently even exist without it."

"We see, finally, that the gray substance of this spinal axis, cannot be the organ of the nutrition of the white substance, since the latter is invariably formed first; since, in some animals, as the *Asterias*, for instance, the nervous system is formed exclusively

of white substance; and since in others, as certain fishes, we can scarcely find the slightest vestige of gray substance in the centre of the spinal marrow."

Besides, that all these passages are false assertions, the reader must be struck with the fact, that Serres could gainsay my proposition in no other way, than by espousing another extravagance of *natural* philosophy, and reversing the mode of animal organization.

Let us for a moment admit, with my countrymen, that the nerves proceed in a miraculous manner from the circumference to the centre, that is, from parts also formed before the centre. Let us admit, what indubitable facts establish, that nerves may exist without a brain, or spinal marrow; yet, does it follow that these nerves have not originated in the non-fibrous substance?

In our Memoir to the Institute, we compared the cortical, gray substance, with the mucous body that lines the skin, all its internal processes, the interstices of the muscular fibres, &c. Vicq-d'Azyr had already said that this mucous substance was analogous to the cortical substance of the brain and cerebellum. It forms with the nervous terminations various apparatus, in the brain, as well as in the intestines and external senses, such as the retina of the eye, the gelatinous tissue of the cochlea of the ear, and the papillæ of the tongue. Haller, too, had arranged the different peripheric terminations of the nerves under one category, in saying that the cutaneous nerves, whose trunks are so hard, are softened according as they part with their cellular tissue, and finally become pulpy in the papillæ of the skin.

"Although these papillæ," he says, "are never destitute of their envelope, and cellular substance, yet they are very soft in the tongue, skin, mammæ, &c., and are always penetrated by blood vessels. The same is the case with the expansion of the nerves in the muscles and heart. The difference of color observed in the net-work of the skin, is not contrary to that

analogy ; for if the mucous body, known by the name of the *rete Malpighii*, is differently colored in the skins of different men and animals, the cortical substance varies no less ; it may be grayish, blackish gray, reddish, pale, or yellow. The same diversity of color is found in the retina, in the pituitary membrane of the nose, in the nervous papillæ of the tongue and palate of different animals. The mucous net-work expanded under the epidermis of animals, presents an astonishing variety of colors. Van der Haar says: 'It is certain that the cortical part of the brain is a soft, pulpy, almost inorganic substance, covering the white part ; but it must be observed, that we find the same constituent parts and the same integuments in the nerves, with some insignificant changes. Can we not, and ought we not thence to infer, that cerebral substance exists in the smallest nervous filaments? How much farther is this pulpy or medullary substance expanded, when separated from its neurileme, or envelope, it is lost in the mucous body! Hence the reason why we cannot prick the skin with the finest needle, without touching the pulpy cerebral substance.'"

Serres cites Fouquet and Bordeu, who also liken the gray substance to the mucous tissue of the skin. Carus and Sprengel are of the same opinion.

If therefore the mucous tissue is nothing but the pulpy, non-fibrous substance of the nervous system, then the latter always gives origin to the nerves, whether they are formed from the centre to the circumference, or from the circumference to the centre. I appeal to the good sense of M. Serres, who appears to be so accessible to the demonstrative force of general laws, and present him the following :

The brain and cerebellum at first contain, in their interior, some large masses of gray substance, or ganglions, for the production and reinforcement of the fibrous, white substance ; and the whole surface of their nervous membrane is also covered externally, with the non-fibrous gray substance. This latter has

the same organic function as the interior; that is, it gives origin to the white, nervous fibres, which converge towards the centre, to form the various junctions or commissures. The existence of the pulpy substance in the extremities of the nerves of the senses, is beyond all doubt. Why then may it not be so with the extremities or expansions of all the other nerves? and why should not this pulpy substance have the same organic function, when placed at the extremities of the spinal nerves? Why should it not furnish nervous filaments, as well as when it lines the extremities of the nerves of sense, and of the hemispheres of the brain and cerebellum?

Those filaments, returning from the peripheric surface of the nerves, very satisfactorily explain how there may be nerves in the extremities, where there is no spinal marrow, medulla oblongata, nor brain. As the commissures are formed by the returning filaments, we understand why they are not formed, till after the hemispheres are sufficiently developed, to furnish returning filaments, and why also the chords of the spinal marrow and medulla oblongata, are not united by commissures. Let me add another remark of much greater physiological importance. I have proved that the organs of animal life have a double mode of function; their function is passive when they receive impressions, active, when they react on those impressions. We smell, and we scent; we see, and we look, &c. An apparatus is required therefore to receive impressions and transmit them to the brain; and another for external action and reaction; "one for sensibility and sensation; the other, for mobility and motion."

If I were not afraid of throwing a new apple of discord among experimental physiologists, I would say, that here is the mystery of the two orders of nerves which some physiologists seek for in the anterior and posterior, or inferior and superior roots of the spinal marrow. However this may be, it will

always prove, that, at least, one part of the nervous system is formed from the circumference to the centre; but that, at the same time, this order of nerves takes its origin in the non-fibrous, pulpy substance.

Let us see now, if in any respect whatever, we can admit that the fibrous, white substance, exists prior to the gray, or non-fibrous pulpy substance. None who have made the most faithful researches on the embryo, have found either nerve, organ, or intervertebral ganglion, existing previous to the spinal marrow; and the reason is, that they made their researches with the intention of seeing what actually is, not like others, prejudiced in favor of an hypothesis, which they are interested in maintaining. They all have seen, that at first, the canal formed by the membranes, is filled with a limpid fluid, which is nothing else but the pulpy substance, in a liquid, transparent state. At this period, it is impossible to recognise any organ. The extremities not yet existing, their nerves cannot exist. Thus the existence of the gray substance is prior to that of the nerves, and as I have proved, while refuting Tiedemann, prior even to the existence of the white substance of the spinal marrow.

In the second month, and not before, the rudiments of extremities begin to appear in the shape of little tubercles; but the cerebral vesicles are already distinct, and the liquid substance of the spinal canal begins to lose its liquid and pellucid appearance. In the embryos of the seventh and eighth week, we recognise the mouth, eyes, and the nasal and auricular openings. The limbs are terminated by a flattened part, from the rounded margin of which the fingers and toes subsequently appear. The head and spine have lost their transparency. The spinal column, the bones of the cranium, and the muscles of the back and neck, are not yet formed. The cerebral substance, at this time, has attained the consistence of the white of an egg. In embryos hardened in alcohol, we distinguish a part of the structure and disposition of the

brain and spinal marrow. The latter is very large and thick, compared with the size of the embryo. As yet, we distinguish only its two chords, but not a trace of fibrous structure. We see the rudiments of the cerebellum, of the tubercles, of the optic thalami, and of the corpora striata. Tiedemann has seen no nerve, at this period, coming from the spinal marrow, or brain. He presumes that their extreme minuteness renders them imperceptible. Neither has he been able to recognise any fibrous substance.

At the third month, we see the restiform bodies forming a thin, narrow cerebellum; and the peduncles, the optic thalami, and corpora striata are more perceptible; but the apparatus of junction, such as the corpus callosum, the fornix, the cornua Ammonis, have not yet appeared. It is not till the eleventh week, that the extremities are developed. The spinal nerves appear on the two sides of the marrow, and the optic and olfactory nerves are seen, terminated by a swelling.

From the anterior and outer margins of the optic thalami and corpora striata, arises the membrane of the hemispheres, produced by the radiation of fibres issuing from those ganglia, or masses of gray substance, which are the apparatus of reinforcement. All the spinal nerves have made their appearance, but the extreme softness of their tissue, and the thickness of their investing membrane, have prevented Tiedemann from tracing them to their origin. As even in adults, the nerves are very easily torn away at their origin, especially, the third, fourth, and sixth pairs, and all the pairs that come from the medulla oblongata, and medulla spinalis, an anatomist, without particular care, might be induced to think, that these nerves have no communication with the pulpy substance, their real origin. It is evident, therefore, that the gray substance, whether liquid and transparent, or thick and opaque, always exists prior to the white substance, to the chords of the spinal marrow, to the hemispheres, to the cerebellum, and to the nerves.

The white substance is never, in the slightest degree, formed previous to, or independent of the pulpy substance. Serres's assertions to the contrary, are entirely gratuitous. He relies on the authority of Cuvier, who once said, that in the asterias, the nervous system is composed exclusively of white substance. Cuvier once maintained too, that in fishes, the sympathetic nerve has no ganglions. Subsequent and more faithful observations have shown the contrary. I have examined the asterias, and have found as many ganglions, or masses of gray substance, in their nervous ring, as there are radii, or larger ramifications from this ring. In Burdach's work, (*Vom Bau und Leben des Gehirnes*), T. I, fig. 1, this ring and the ganglions are very well represented. Burdach expressly says, that in the asterias and holothurias, these ganglions cannot be overlooked. Merkel and Conrad have also described and figured them. Burdach adds, p. 205, that Carus had maintained, on the authority of Cuvier, that there was no difference in the nervous substance of the invertebral animals, but that Swammerdam had already distinguished the two substances in bees. He recognised, like Reil, some gray substance in the mollusca, and like him, too, Merkel holds that the gray substance exists, wherever there is any nervous system whatever. In insects, the gray substance occupies the interior; the white, the exterior. Even Carus has observed, that in the invertebral animals, the whole ganglion, or at least the nucleus, exists in the gray substance. In the *Ascaris lumbricoïdes*, Baer has observed the same swelling, and the nerves which proceed from, or have, he says, with Burdach, proceeded to them; a view which is adopted by Serres.

"Pursuing his notions on the encephalon," continues Serres, "Gall says that the grayish swelling of the brothers Wenzel, is the matrix of the auditory and facial nerves. This supposes, that the swelling exists previously to the nerves, but not only are these nerves formed without the cranium, and at first with no com-

munication with the encephalon, but even when they have reached the spinal marrow, the gray matter of the tænia of the Wenzels, has not yet appeared. This swelling is not developed, till many months after the nerves are implanted in it."

There are several things in the passage, which M. Serres will pardon me, for not believing, merely on his word. Let us admit, for a moment, that the auditory nerve exists before this swelling. We have never said, that the tænia is the sole origin, the only ganglion of the auditory nerve. I have always thought, that it was with this nerve, as with almost all the rest — that the more perfect the function is, the more numerous are the origins; and the origins multiplying, the number of their ganglions increases, the nearer the nerves approach the epoch of exercising their functions. Thus, Serres himself acknowledges, the two largest swellings of the spinal marrow, coincide with the appearance of the limb. Thus, too, the olivary ganglions and corpora geniculata also appear, subsequently, though not after the nervous filaments to which they adhere, to give origin to new filaments, designed to reinforce those already formed. Serres deceives himself or his readers, in attributing to us the opinion, that the corpora geniculata are the sole origin of the optic nerve, in order to fasten upon us the conclusion, that the nerve exists before the gray substance. How could Serres imagine, that nerves coming from the circumference, could plunge into these ganglions, if they did not exist, at least, simultaneously?

Serres says, p. lii, that the medullary bundles of the pons Varolii are developed before the gray substance of the pons itself, and that the peduncles of the pineal gland are invariably formed before the gland. To publish such errors with so much assurance, leads us to suspect, that M. Serres counts upon the ignorance of his readers and judges. So long as the ganglion called the pineal gland, does not exist, its peduncles do not exist. Tiedemann never saw this

ganglion till the nineteenth day, when he could also recognise two little peduncles. The medullary bundles of the pons Varolii, are the commissures of the hemispheres of the cerebellum, and their existence and successive increase coincide with the formation of the folds of these hemispheres. It is precisely in the canal, in the medulla oblongata, and in the pons Varolii, that the gray substance abounds, before we can distinguish any fibrous substance. The numerous instances of such incorrectness, must caution us how we give our assent to Serres's assertions, before verifying them ourselves.

What Serres says of the centrum ovale and of apoplectic cysts is founded, partly, on a mere chimera, since the centrum ovale is an artificial production, and partly, on an interpretation so arbitrary, that I may dispense with replying to it.

Unless Serres is willing to admit an eternal vacillation in the laws of the formation of the nervous system, we can, every moment, find in his own observations, things that refute his hypothesis. He says, page 45, that the surface of the optic lobes assumes a whitish aspect at the tenth day of incubation, by which they are distinguished from the anterior lobes that are always gray, and from the cerebellum, which is of a reddish gray. This white color becomes more and more marked, at the fourteenth, eighteenth, twentieth, and twenty-first days of incubation, and this constitutes the normal state of the interior of these lobes in all adult birds. The aspect of these lobes is grayish, until the ninth day, when there appears in their interior some whitish striæ, which gradually enlarge, till their margins touch and unite together, and in this manner is produced a medullary layer, which forms a kind of cortex over their whole periphery. Until the twelfth day, the whole mass of the exterior lobes is of an ash gray; but at this period, and during the fourteenth, fifteenth, and sixteenth days, even till birth, we perceive some whitish

fibres, forming a thin layer on the inner part of the lobes, and which may be very readily distinguished by separating them. At their base, we see them uniting together in a pellicle.

In the spinal marrow of lizards, observed twelve days after birth, Serres has seen in the interior of the gutter that forms the spinal marrow, a substance browner and more liquid than the lateral parts of the chords, extending the whole length, and lining the whole inside of the spinal marrow. He says, page 105, that the spine, or canal, is at first filled with a liquid, and that the layers of the marrow become successively thicker, in proportion as the liquid takes the consistence of gray matter.

Now I leave it to the reader to decide, whether Serres is wrong in maintaining the priority of the existence of the fibrous, white substance, or whether the laws of the organism are complaisant enough, to accommodate themselves to the caprices and inconsistencies of anatomists.

In the following passages, particularly, Serres declaims against the idea of the white substance being posterior to the gray, and originating in it.

"I remark, in the first place, that in the system of the German physiologists, the gray matter is supposed to be the matrix, or nutritive matter of the white; — a revival, apparently, of the hypothesis of the secretion of spirit by the gray substance, of which the fibrous matter constitutes only the excretory ducts."

The stem nourishes the cherry, therefore, according to Serres's reasoning, it follows, that the stem secretes the spirits, and that the cherry is the excretory duct. To find a man guilty, it is merely necessary to invent a crime, a manœuvre that has been very often practised upon me.

"The two hypotheses," he continues, "suppose a direct communication between the two substances, which indeed is the case in the cerebellum and cerebral hemispheres of adult animals, but not in the spinal

marrow and the corpora striata ; for, in the mammifera and birds, we may remove every layer of the gray substance of the spinal marrow, without in the least involving the white substance. In the mammifera, we may also remove the gray matter of the corpora striata, without tearing or otherwise affecting the fibrous matter."

These are bold assertions wherewith to astonish novices in anatomy. Wherever there is gray and white substance, there exists a direct communication between them. Nervous fibrils, however, which issue from the gray substance, are so fine and delicate, that the slightest force is sufficient to rupture them. What precautions are necessary, in order to preserve the adhesion, the direct communications of the third, fourth, sixth, eighth, &c., pairs of nerves ! The communication of the nerves with the gray substance of the spinal marrow, can be seen only by carefully pulling out one of the stoutest nerves, when there will always be found a little bulb of gray substance, adhering to the central extremity of the nerve. Can an anatomist, on whose faith we are required to believe so many invisible marvels, assert that the corpora striata have no direct communication with the white substance ? What then is the use of those numerous large, white, and fibrous bundles in the corpora striata, and which, having traversed them, expand like a fan, in order to form a part of the inner layer of the cerebral membrane ? And how are those white, fibrous striæ and bundles formed ? Make an incision in the gray substance which presents itself in the ventricles, or remove a thin layer by scraping, and you will see an infinite number of very white filaments, proceeding towards the large bundles for the purpose of reinforcing them. The same thing is evident in the outer half of the corpora striata, enveloped in some little convolutions under the middle lobe, and also in the optic thalami, in the great peduncles, pons Varolii, &c. In fact, we may raise and unfold these little

convolutions, that envelope the outer and greater half of the corpora striata, without affecting the latter; but these convolutions are not formed directly by the gray substance,—they are nervous bundles, white striæ, resulting from the confluence of innumerable filaments formed in these large masses of gray substance.

Serres continues: “In the primitive state of young embryos, the layer, which forms the cortical substance of the cerebral hemispheres, is placed only in juxtaposition to the layer of white matter; they do not even adhere together. Ruisch removed in an infant, the whole cortical layer of the hemispheres, without affecting their white substance. If we believe in nutrition, how is it effected? Are there canals of communication between the two substances, as is admitted in the hypothesis of animal spirits? What is the nutritive fluid, and how does it circulate? What is the matter of reinforcement? These things are not explained.”

Our anatomist, then, does not know that the blood-vessels of the pia-mater or vascular membrane, penetrate into the cortical layer, traverse it and follow, uninterruptedly, the fibrils of the subjacent layer of white substance? In separating the gray from the white layer, these vessels are necessarily torn—the first reason, why the white layer *is* involved. I have often removed the gray layer in adults and children of different ages, and I have invariably seen, that the gray substance of this layer, is every where penetrated by white filaments, which are continued into the white layer, and which we cannot avoid breaking—a second reason, why the white layer must inevitably be involved. If, then, the blood-vessels have any thing to do with nutrition, Serres will discover in this disposition, the means of nutrition and reinforcement.

“In the second place,” adds Serres, “a consequence of this hypothesis is, that the gray matter should always be in proportion to the white. But, in the

spinal marrow, this relation, instead of being constant, is, in fact, inverted. Thus, as we descend the scale of mammifera, from the monkeys to the rodentes, and from them to the birds, the white matter goes on increasing, and the gray diminishing. In all the fishes, the predominance of white matter is still more marked, and in many, we shall hardly find a vestige of gray matter in the spinal marrow. This hypothesis, therefore, being in manifest opposition to facts, is not admissible."

What may be the proportion between the two substances, I cannot say, but not permitting myself to give supposition for facts, I can announce it to be a constant fact, that the more copious the white substance is, the more copious also is the gray. The layer of gray substance, that furnishes the numerous filaments of the olfactory nerve, and its bulb of gray substance, as the cribriform bone, are much larger in the mole, dog, ox, &c., than in man. The tubercula quadrigemina, one of the origins of the nerve of vision, and the tænia, the ganglion of reinforcement of the auditory nerve, are much larger in the horse, &c., than in man. The optic thalami, the corpora striata, the pons Varolii, the crura cerebri, are always in proportion to the hemispheres, — much larger in man for instance, than in the greatest part of the mammifera.

The medulla oblongata is proportionally more swelled, and more abundantly furnished with gray substance, in most of the mammifera, because it gives origin to larger nerves. In the spinal marrow, the swellings whence the brachial and crural nerves arise, so predominate over those that give rise to the other pairs, that anatomists, for want of sufficient attention, still overlook the latter. Here then is a general law, that undergoes many modifications indeed, but admits of no essential exception.

In the polypi, &c., the two nervous substances are still confounded, and here, there might be some ground for talking about homogeneousness, and unity of com-

position. The gray, or rather the non-fibrous substance, nowhere exists, not even in the brain of the mammifera, entirely pure, completely isolated from the fibrous substance. Examine carefully the gray substance of the pons Varolii, of the tubercula quadrigemina, the pineal gland, the olivary bodies, the corpus fimbriatum, the fourth ventricle, the peduncles of the brain, the optic thalami, the corpora striata, and corpora geniculata; examine the gray substance that surrounds the union of the optic nerves, that which gives origin to the numerous filaments of the olfactory nerve in brutes, the bulb on the cribriform bone, even the striæ of gray substance, which accompany the olfactory and optic nerves in man; examine the gray substance of the mamillary bodies, that which is found in many animals, the wolf and dog, for example, on the posterior fold of the great commissure of the hemispheres, and you will see, that it is every where mixed with nervous filaments, and thus intimately penetrated with white substance, which proves, that those filaments arise there, and that it is not always essential to their function, that they should form nervous chords, separated and distinct from their very origin. How, in this case, are we to estimate the different proportions of the two substances, in birds, ophidians, saurians, &c.? According to Serres, it may be, exclusively, the gray substance, or exclusively the white substance, that exercises the functions of the whole nervous system; for he asserts, though in opposition to Swammerdam, Meckel, Konrad, Reil, Carus, Burdach, &c., that in the invertebral animals there is no gray matter, and that their nervous system is formed exclusively of white substance.

In Burdach's work, T. I, Pl. I, fig. 4, is a faithful drawing of the nervous system of the crab. All the little collections of gray matter, that give origin to the nerves; that is to say, all the ganglions are very well marked, particularly those that send nerves to the nippers. Even the five ganglions of the tail, form very

distinct swellings. Serres's figures are far from being true to nature; they are very inaccurate, and coarsely executed. In my large work, T. I, Pl. I, fig. 2, is the spinal marrow of the hen. At first, the collections of gray substance form ganglions at the origin of each cervical nerve; then comes a very broad, and pretty long swelling for the nerves of the wings; the other ganglions form swellings, till we come to the largest of all, those for the crural nerves. In birds, however, whose powers of flying predominate over those of running, the order of size in these two large swellings, is reversed. But it is invariably the case, that the gray substance is as abundant in birds, as in the mammifera.

In his remarks relative to the gray substance of the spinal marrow of fishes, Serres appears to have reference to an observation of Arsaky, who professes never to have seen gray substance in the spinal marrow of the zitterochen, (*Raia torpedo*, L.) But he found that this canal has a cavity, presenting the same form as that produced by the gray substance in the interior of the spinal marrow in other animals. It is to be presumed, therefore, that Arsaky made up his opinion hastily, and for a still stronger reason too, that in all other fishes, the gray substance of the spinal marrow is managed in the same manner. As in the mammifera, it is more abundant in the upper than in the lower region, which makes the dorsal furrow deeper than the abdominal; it is visible externally on the sides, at the origin of the spinal nerves. See Carus, p. 131, and Pl. II., fig. 16 and 15. Tiedemann also has observed, p. 86, that in all species of fishes, the walls of the canal of their spinal marrow, are furnished with gray substance.

The same is the case in the nervous system of voluntary motion in the caterpillar, (large work, Pl. I, fig. 1), as Serres himself acknowledges. But he maintains, with some German anatomists, that this system is not analogous to the spinal marrow of fishes, birds,

and the mammifera. This system reaches from one extremity to the other, on the median line, and presents very distinct cords on the right and left. At each segment of the animal, these chords swell into a ganglion, which furnishes to the right and left side nervous filaments, that are distributed to the muscles of each segment, that executes voluntary motion. A man must have a rage for singularity, to mistake this system, which is not merely analogous to, but is precisely the same as that of voluntary motion in fishes, birds, and the mammifera.

Serres denies, p. 557, apparently on the authority of Carus, that the spinal marrow presents any swelling, formed by the gray matter at the insertion, according to him, and the origin, according to me, of the spinal nerves. "In no class," says he, "do we see a series of swellings, corresponding to the series of the insertions of the spinal nerves. The spinal marrow of fishes is particularly remarkable in this respect. We have observed no swellings in it, though the spinal nerves are very much developed, especially in the cartilaginous fishes."

Carus says, that these ganglions of the spinal marrow do not harmonize with the organization of the mammifera, p. 218. Why not?

I was the first to recognise, in the spinal marrow, the two large swellings of the lower and upper limbs, because they had no idea of the use of the gray substance. And now they would voluntarily sacrifice this truth, if their eyes did not present too large an obstacle to the spirit of party. What anatomist dares to deny the existence of these ganglions in the caterpillar? and if they are disinclined to acknowledge the most striking analogy, I appeal to birds of all classes, and to all the mammifera. What confidence can be put in anatomists, who refuse to believe the testimony of common sense, and their own eyes? They see, that wherever there are swellings of gray substance, there arise, or if Serres prefers, there are inserted, nerves. They

see, and are forced to avow, that where the largest nerves originate, we have the largest swellings. They profess to be the partisans of general laws, and are inconsistent enough to pretend, that the other smaller nerves do not require smaller swellings. Snakes, having neither anterior nor posterior limbs, are also devoid of the two large swellings in their spinal marrow; but, at the origin of each pair of nerves from their long spinal marrow, there is invariably, a little round swelling. Carus also says, p. 173, that after careful examination, it can no longer be denied, that these swellings exist at the origin of the nerves, in the spinal marrow of the *Coluber natrix*. The same is the fact in the eel, and all fishes, even in the *Tetraodon mola*. Although the length of the spinal marrow does not exceed that of the brain, yet these swellings are very distinct, (Carus, p. 128.) It is understood, that the swellings, corresponding to the fins, are the largest. The *Trigla* genus, remarkable for the separation of the rays of their pectoral fins, are also remarkable for a series of swellings proportioned, in number and volume, to the number and volume of the same rays, to which they correspond, (Cuvier's Report on Serres's work, p. xxii.) The electric fishes have also a considerable swelling, corresponding to the nerves that are distributed to the electric apparatus, (p. xxiii.)

Again; if we will examine those animals whose vertebræ are quite long, we shall see, that the canal in each vertebra is invariably enlarged at the two extremities, where it is contiguous to the other vertebræ; and it is in this place, at this enlargement of the vertebral canal, that the ganglions are placed. In order to avoid repetition, I refer the reader to what I have said on this subject, T. I, 4to. p. 37, &c. &c.

Why does Serres admit, that the medulla oblongata, pons Varolii, optic thalami, corpora striata, present swellings of gray matter, in a certain relation to the white substance, which originates in it, or, as he says,

that these swellings are in relation, in the different classes, to the volume and number of the medullary bundles, which traverse them? He admits it, because these parts are so voluminous, that his readers could not be imposed on, unless they were totally blind.

"But," says Serres, "does this prove that the white matter originates in the gray? Anatomy returns a negative to this question; for Ruysch never succeeded in reddening the white matter in his injections, and Willis never could demonstrate fibrils, issuing from the gray matter and proceeding to form bundles. Malpighi failed in his attempts to trace the white bundles from the glandular follicles, of which we considered the gray matter to be composed. Have Gall and Spurzheim succeeded any better? I find no proof to that effect in their works."

Yes, Gall and Spurzheim have succeeded better; and M. Serres may enjoy the same happiness, whenever he is inclined to consider the swellings of the spinal marrow and medulla oblongata, the pons Varolii, the tubercles, the optic thalami, the corpora striata, the bulb of the olfactory nerve, the pineal gland, the mammillary bodies, &c. &c.; his eyes will every where light upon numerous nervous filaments, which are formed in the gray substance, and issue from it, for the purpose of forming nerves and nervous bundles. Serres goes so far, p. 569, as again to rest upon his great authority, M. Cuvier, who, as I have already shown, from a passage in his report, was one of the first to recognise this discovery.

It is said again, that, if these swellings of the spinal marrow did really exist, we ought to see them in embryos, where, however, we find nothing like them. How far, we may ask, has this been well observed? The olivary body, the corpus geniculatum, are not seen in embryos; are they to conclude with Tiedemann and Serres, that they do not exist in adults?

After these digressions, Serres reminds us again of some of his numerous errors; for example; "that in

all embryos without exception, the white matter is formed before the gray in the spinal marrow." Refuted in the review of Tiedemann's work. Again, that in the olivaria, the white matter is developed before the gray. "Frequently even," he says, "the latter is not formed at all, as in birds, reptiles, and fishes."

Such assertions prove, how little Serres knows of the true laws of the successive formation of the parts of the nervous system. So long as the gray substance is not in existence, the white, which is formed and continued by it, does not exist. At this period, the parts of the brain dependent on this ganglion (the olivary bodies) have not yet appeared, and never do appear in the simpler brains of the reptiles, fishes, birds, and even the mammifera, excepting man only, and perhaps the monkeys. This is the reason, why these animals never possess the olivary bodies. As soon, however, as the new cerebral parts are to be formed, the matter to be used for this purpose must be deposited from the circulation; the olivaria appear, and with them their white substance, that is, a particular bundle, whose direction is different from that of the bundle wrongly called the middle bundle, from the erroneous impression that there are three bundles, on the anterior surface in man, and the inferior surface, in brutes, of the spinal marrow.

Carus has charged me, (T. I, p. 280, and 287,) with having declared the olivary bodies to be ganglions of the hemispheres, or as he expresses it, ganglions of the optic thalami and corpora striata, which he has called ganglions of the hemispheres. It is notorious that we were the first, who, upon physiological principles, conceived and published these peculiar views of the use of the ganglions. (See T. I, p. 282 4to. and a thousand other places.) In respect to the olivaria, we held the following language. "The olivary bodies are only a ganglion, like the corpus fimbriatum of the cerebellum. A large bundle proceeds from the ganglion, which ascends with the posterior bundles of the

great swelling, behind the coarse, fibrous bundles. All these bundles ascend, like those of the pyramids, between the transverse fibres of the commissure of the cerebellum. In their passage, they are reinforced. Above the ganglion, they constitute the posterior and inner part of the large fibrous bundle. They acquire their greatest increase, at their entrance into the large fibrous bundle, from the great mass of gray substance collected there, and which, with the nervous filaments it produces, forms a ganglion, pretty hard, flattened in the middle, and unequal above and behind." The olivaria, therefore, according to our views, only concur with the gray substance of other ganglions, in successively augmenting the fibrous bundles. Carus rejects this opinion, because, says he, the olivaria exist in but a few mammifera. Once I really thought, that the olivaria existed in the large mammifera at least, since their medulla oblongata is very much swelled out on the outer side, and that being much smaller than in man, they were buried in the prominent part. Since Carus's work appeared, I have again examined the medulla oblongata in the ox and horse, and as I have never been able to discover any thing like the interior of the olivaria in man, I believe, with him and Serres, that the olivaria do not exist in them. But I cannot agree with Carus, that we ought not to admit a series of several ganglions, as the complement of the organization of a nerve, or a hemisphere. The nerve of vision, certainly, has several ganglions of origin and reinforcement, and so has the olfactory. So, too, besides the pyramids, the olivaria, the annular protuberance, the great fibrous bundles, the optic thalami, the corpora striata, must be considered as so many apparatus of origin and reinforcement for the hemispheres of the brain. As in the formation of the nerves, so it is in that of the hemispheres, the more perfect the hemispheres are, the more numerous are these ganglions, or apparatus of origin and reinforcement; so that sometimes

the corpora striata, sometimes the optic thalami, and sometimes the olivaria are wanting. Carus says that this view involves the idea, that one part is produced by another part, which would be incompatible with organization, because each part, he thinks, originates in the place where it actually is. In fact, each part does originate in the place where it actually is, but it is necessary, that the organization should first arrive at that place, where a new apparatus is to originate. I do not say that the ganglions originate from one another, but that each ganglion produces a certain number of nervous fibrils, which, in order to acquire a fresh increase, must pass through a new collection of non-fibrous substance.

We have taken some pains to follow the nervous bundles produced by the olivaria, and we have never succeeded in tracing their course into the tubercles, as every body else professes to do. According to Carus, these tubercles exist in man, at the third foetal month; according to Tiedemann, much later; and according to Serres, they are not visible till the fifth month, when the olivaria have not yet appeared. The latter are evidently wanting in the reptiles, fishes, and birds, where these tubercles are very large. These tubercles are much larger in the large mammifera, than in man, and if the olivaria be not altogether wanting, they are, at least, not distinctly visible. Thus our first idea is confirmed, that the olivaria are a true ganglion for the same convolutions, which acquire their entire mass of fibrous substance in the optic thalami, and that they have no connexion nor relation with the tubercula quadrigemina.

3. "The white bundles constituting the trapezium, are developed before the grayish swelling of the Wenzels, which is considered as their ganglion."

Why not say, which is considered as one of their ganglions — a ganglion of reinforcement. As to the rest, we have the same error, and we return the same reply.

4. "The medullary bundles of the pons Varolii, appear before the gray matter scattered among them."

Does Serres refer to the longitudinal medullary bundles of the medulla oblongata, of the pyramids? If so, I have proved that the gray substance exists in the whole vertebral canal and annular protuberance, before the white substance, either in a liquid state, or possessing more or less consistence. Or does he mean the transverse bundles of the commissure of the cerebellum? The commissures rarely have any gray substance, but they originate from it, especially that of the cerebellum from the gray substance, covering the whole outer surface of the fibrous membrane of the cerebellum. Besides, both are swimming in gray substance from the first moment of their appearance.

5. "The white bundles of the optic nerves, that proceed to the corpora geniculata, exist long before the gray matter composing the latter."

The same remarks relative to the olivary bodies, are also true of these bundles and the corpora geniculata.

6. "The peduncles of the pineal gland are formed before this body; therefore, this body is not their ganglion, nor matrix."

The same error, the same gratuitous, arbitrary assertion; already refuted above.

The fact of cicatrization, which Serres invokes in his favor, proves absolutely nothing. Wounds cicatrize wherever there are vessels, and all nervous filaments from the brain, are accompanied with blood-vessels. Very often, particularly in young subjects, the transverse striæ of the great commissure, are intermixed with a substance of a dusky white, or yellowish tint, which leads us to presume, that they are not entirely devoid of gray substance.

All Serres's arguments against the priority of the non-fibrous substance, and in favor of that of the white, are reversed, therefore, by the most exact disposition of the nervous system in all classes of ani-

mals. Finally, we have arrived at Serres's favorite hypothesis. "Why," he asks, "have anatomists constantly persevered in attributing the origin of the white matter, to the gray? It is owing to a fundamental error laid down as a general principle, — to a preconceived idea, that the nervous system is developed from the centre to the circumference, and that the gray matter is formed before the white."

Is the Nervous System formed from the Centre to the Circumference, or from the Circumference to the Centre?

"It is strange," exclaims Serres, "how they have interpreted nature in precisely the inverse direction. They have supposed a course directly opposite to what she really pursues; ought we then to be astonished, that her laws have been misunderstood?" "From this eccentric course result the laws of organization; every organ being primitively double, its parts, at first isolated, proceed to meet one another and unite on the centre of the animal, forming organs which are called single."

Either the liver, spleen, and pancreas, are not organs, or Serres's assertion thus generalized, is false. It has always been a familiar fact, that animals are chiefly composed of two symmetrical halves, and I have proved, that the organs of animal life are all double. I do not recollect that these organs were ever called single; the os hyoides, the lower jaw, and sternum, have always been known to be composed of two halves. Now Serres believes, that the formation of membranes, bones, intestines, trunks, canals, &c., is eccentric! He invokes the judgment of the Royal Academy of Sciences. I much prefer facts to the judgments of Academies. But if the latter should have had the preference, where should we be, now that Academies have come into existence, with

their thousand reports, more especially too, if these reports had been received as law by the whole world!

According to this hypothesis, the fingers and toes are formed before the trunks of these extremities, and the latter, before the central parts of the body. In the same way, the leaves and flowers are formed before the branches; the branches, before the stem; and the stem, before the root! But let us leave all these gratuitous suppositions and arbitrary assertions, and confine ourselves to the nervous system. Let us follow its progressive development, or origin.

At the first month, the swellings representing the head and spinal marrow, contain a thin transparent fluid. At the second month, this fluid becomes whitish and less diaphanous, and is gradually transformed into the spinal marrow and brain. By the seventh, or eighth week, the head and spine have lost their transparency. At this period, the vertebral column, the cranial bones, and the muscles of the back and neck, are not yet formed — another proof against the eccentric formation. A little later, this substance, once so transparent, and which is said to have no resemblance (no relation according to Jourdan) to the fluid that before occupied its place, becomes pultaceous and of the consistence of the white of an egg. Its anterior face (exterior of Jourdan!) presents two cords, in which we can, as yet, discern no trace of fibrous structure. Recollect now, that they wish us to believe, that the fibrous substance exists previous to the non-fibrous substance! On each side of the fourth ventricle, there rises from the spinal marrow, a thin narrow layer, which is folded inward and laid against that of the opposite side, but without uniting, or being blended into a single mass, with it. These two cords are the rudiments of the cerebellum, in front of which, we also perceive two other membranous productions, the rudiments of the tubercula quadrigemina. Then come two rounded protuberances, the optic thalami, in front of which, are placed

the rudiments of the corpora striata. From these two last eminences arise two membranous productions, recurring from without inward, and from before backward, which form the commencement of the hemispheres of the brain. Tiedemann has been unable to find, even at the ninth week, a trace of any other part of the encephalon, particularly of the annular protuberance of the commissures, of the corpus callosum, of the fornix and its dependences. He saw no nerve proceeding from the brain, or spinal marrow, the substance of which examined by a magnifying glass, presented no fibrous structure. During the second month, we recognize on the spinal marrow, seven cartilaginous nodules, but see nothing of ribs, nor limbs. At the eleventh week, we can scarcely discover any traces of the muscles of this region, which is still soft and whitish. At this time, we can only perceive the swellings of the origins of the nerves designed for the thoracic and pelvic limbs, and that of the medulla oblongata, as well as the cerebral and spinal nerves, quite large in proportion. The olivaria have not yet appeared, nor the annular protuberance. The hemispheres are still separated from each other longitudinally, by a deep fissure. In the cerebellum is no trace of processes, lobes, or laminæ. The anterior cerebral lobes are more developed than the middle and posterior, and in the anterior lobes, we observe the first origin of the commissure of the hemispheres. This origin of the great commissure from before backwards, evidently proves, that the commissure is not formed of fibres that come from the peduncles, the optic thalami, or corpora striata, because if it were, it ought to be formed from behind, forwards. At the fourth month, the spinal marrow has a fibrous texture on its anterior face, and sides. The posterior cords as yet, present, no fibres. The annular protuberance begins to appear. With the ciliary body there successively appear the ramifications of the cerebellum, and the annular protuberance is more and more enlarged,

just as the commissure of the hemispheres becomes longer, in proportion as the middle and posterior lobes are more developed. This development of the middle lobe also gives rise to the anterior commissure.

Thus, therefore, we have in the spinal marrow, at first, a transparent fluid, which is transformed into a gelatinous, non-fibrous substance, then the cords of a white fibrous substance, and finally, swellings which give origin to the spinal nerves. In the cerebellum, the middle, fundamental part, or as Serres calls it, the little thin tongue, exists before its lateral parts. In the brain, the tubercula quadrigemina, the peduncles, the optic thalami, the corpora striata, the anterior, middle, and posterior lobes of the hemispheres, are successively formed.

Is there any better proof, that the formation of the spinal marrow and brain takes place from the centre to the periphery? If the formation took the opposite course, the nerves would exist before the swellings; the swellings, before the fibrous substance; the fibrous cords, before the gelatinous, non-fibrous substance; the hemispheres of the brain would precede the corpora striata and thalami; the corpora striata and thalami would precede the peduncles, and all the parts would be anterior to the tubercula quadrigemina.

Since Serres maintains, that the brains of embryos at first resemble those of fishes, then reptiles, and finally, birds, it is equivalent to acknowledging that the most central parts are first formed; for, fishes and reptiles have only the rudimentary parts of the brain of the mammifera.

When Serres adduces, as an argument in favor of his hypothesis, the fact, that the right and left cords of the spinal marrow, and the hemispheres of the brain and cerebellum, are not at first united by commissures, he shows, that he does not understand the laws of the organization of the nervous system. I have demonstrated, that it is the nervous filaments, engendered in the non-fibrous substance of the surface of the cere-

bellum and brain, which, by converging towards the centre, form the annular protuberance, or commissure of the cerebellum, and the anterior commissure and septum lucidum, or commissures of a part of the middle lobes, and the corpus callosum, or great commissure of the hemispheres with the fornix. Now, the surface is last formed, consequently the unions or commissures must also be formed last.

Is his theory any better supported by the succession of the muscles? On the contrary, it furnishes new proofs of the centric formation. They all begin near the spinal column, the centre of all formation; first, the muscles of the vertebral grooves, then the intercostals, and finally, the muscles of the sternum. On the abdomen, the oblique on the sides come first, and afterwards, the secti and pyramidales which are farthest removed from the vertebral column, since, in embryos, the abdomen presents a vast opening. As the muscles proceed from the circumference, where they have been last formed, to meet their congeners, they shut up the abdomen and enclose the intestines.

Serres explains the monstrous formations of the nervous system, by saying that their evolution is arrested at the fundamental parts of reptiles, fishes, birds, or such or such of the mammifera. Now this explanation is intelligible only, on the supposition that the nervous system is formed from the centre to the circumference.

If it be true, that the lateral nerves of the trunk, head, and pelvis are first formed; that they exist independently of the spinal marrow; that they acquire all their development, while the cerebro-spinal axis is yet in a liquid state, &c., as Serres says, I have given the reason above, in speaking of the origin of the nerves from the mucous tissue of the muscles, skin, &c. But let us be on our guard, whenever an author is interested in misapprehending facts, in order to favor a published opinion!

Serres strongly insists on the anatomical truth, that

the development of the nervous system of the cerebellum and brain, is under the influence of the arterial system. But certainly, the arterial system is not developed from the circumference to the centre, and admitting that the venous system follows this course, we then embrace a proposition which I have already maintained in several places, viz., that there are nerves designed for the perception of outward impressions, and for their transmission to the sensorial organs. This disposition would be analogous to the returning, converging system, and the commissures of the brain and cerebellum, which I have demonstrated. Another order of nerves would be the nerves of reaction, equally analagous to the nervous system that diverges from the brain and cerebellum. Thus there would be nerves, formed from the centre to the circumference, and others, from the circumference to centre.

It is pretended, that the optic nerve is already formed before being connected with the brain. It needs a pretty strong authority to establish as a fact, a disposition, which, considering the precocious existence and development of the tubercula quadrigemina, presents no appearance of probability.

Serres himself says, p. 119: "The radiation from the central nucleus of the hemispheres of the cerebellum, is in relation to the divisions of the hemispheres. At the fourth month, the scarcely perceptible nucleus presents no apparent radiation; at the fifth month, one or two radiations are seen, and then there are two or three lobes; at the sixth month, a third radiation coincides with the fourth lobe; and when there are four radiations, there are also five lobes on the outer surface of the cerebellum." It results from these relations, that the development of the fissures and lobes, is immediately dependent on the central, medullary nucleus. The formation of the cerebellum, therefore, is from the centre to the circumference. And as this nucleus, which Serres, with some Germans, calls

the medullary nucleus, is, in reality, nothing but a nucleus of gray substance, he, in fact, admits, that the white, fibrous substance of the cerebellum takes its origin from the gray, non-fibrous substance.

After adding, that the development of the cerebellum is subjected to the successive increase of the calibre of the vertebral artery, he ventures to deduce, as a legitimate result, the following conclusion, the very contrary of which flows from his premises. "We see, from this description, that the cerebellum is developed from the circumference to the centre, and not from the centre to the circumference, as Tiedemann thinks." Serres's whole work swarms with such conclusions, diametrically opposed to his premises, and solely designed to take by surprise, the credulity of inattentive or ignorant readers.

Serres himself cites observations, that most evidently prove, that even the formation of the limbs is dependent on the ganglions of the spinal marrow. In two human embryos without lower extremities, the lower part of the spinal marrow was not swelled. In two cats and one dog, destitute of the hind feet, the inferior swelling of the spinal marrow was wanting. In a human embryo destitute of the upper limbs, the spinal marrow was not swelled in the cervical region, and a cow affected with the same monstrosity, presented the same disposition. If the formation commenced at the circumference, the swellings would not be necessary, while it is altogether different on the supposition of central formation. The ganglions not existing, in consequence of a defective organization, the nerves that control the limbs, could not arise.

On Serres's hypothesis, the organization of the nervous system would be subject to one law, in one place, and to another, in another place. It is evident, that the pyramids go on enlarging, till, after their decussation, they are found on the anterior or inferior surface of the medulla oblongata; that in their passage through the annular protuberance, they form large, nervous

bundles, or the peduncles, which are again enlarged in the thalami and corpora striata to such a degree, as to produce a great part of the expansion of the white substance of the hemispheres. It is equally evident, that the olfactory nerve increases during its whole course, until it reaches its bulb, where it receives a fresh increase, preparatory to its expansion in the nose. It is evident, that the optic nerve, after taking the first demonstrable origin in the anterior pair of tubercles, increases in mass, in the inner and outer corpora geniculata, in the peduncles, in the gray layer situated behind and upon its junction, and even in its course thence, to its insertion in the bulb of the eye. It is demonstrated in the same way, that all the nerves enlarge or become conical, in proportion to their distance from their origin, being always accompanied with blood-vessels and gray substance. This successive increase, is perfectly explained, on the theory of the formation from the centre to the circumference, by the fresh filaments, which are added in the new beds of gray substance. But, admitting the formation from the circumference to the centre, the nerves should go on diminishing, notwithstanding the different masses of gray substance they encounter in their course. Finally, how are we to explain the existence of the diaphanous, liquid substance, successively transformed into gray substance, in the spine, and the gray substance between the exterior and posterior cords, of the marrow, long before the existence of nerves?

If the transmission of impressions to the brain, proves any thing in favor of the peripheric origin of the nerves of sensation, the propagation of irritation and motion, towards the extremities, when we irritate the nerves of motion, is a proof in favor of their central origin.

I therefore declare Serres's hypothesis, taken generally, to be contrary to the laws of formation in the vegetable, as well as animal kingdom. I declare it to be a most extravagant hypothesis, designedly adopted because it afforded a ground for finding fault with, and

utterly depreciating every thing done by anatomists and physiologists, before Serres. I say *designedly adopted*, because it was not in Serres's researches, but in the inflamed imaginations of the transcendental philosophers of Germany, that this fiction took its rise. See the language of Burdach, in his work, printed in 1819. "The nervous system exerts its action in a double direction, from without inwards, and from within outwards. The former will first occupy our attention. Every physiological consideration of the nervous system must begin at the periphery, and proceed to the centre, for it is necessary that the exterior should be first formed, in order that it may be able to act towards the interior. In the embryo, the veins are formed before the arteries, and the upper half of the intestines is developed, sooner than the lower half. At birth, inspiration occurs before expiration, and through life, nutrition begins by the action of the absorbents and veins. The action of a nerve from the periphery to the centre, is the primitive and essential action. The nerve acts in a purely dynamic manner; it receives impressions at its periphery, and transmits them from all sides to the common centres, where they meet and form a unity."* Here begins such a mystical and absurd rhapsody on the universal soul of the world, on materiality transformed into spirituality, and spirituality transformed into materiality, &c. &c., that it is impossible for me to discover in it, any sense whatever, or to continue the translation. But this passage is sufficient to show, where Serres borrowed his grand conception.

In the mean time, however, Burdach modifies his notions. "Sensibility does not originate from a single point, thence to be spread over other parts; it is manifested in every point of the nervous system, so long as each one preserves its reciprocal action with all the rest. Considering its double reciprocity, we cannot

* Vom Bau und Leben des Gehirns, p. 41.

say of a nerve, that it arises here, and terminates there. We can only say, it extends between its central and peripheric points. Its origin, in respect to sensation, is at the circumference; in respect to reaction, at the centre. Though, in neurography, it would be more convenient to derive the nerves from the brain and spinal marrow, it better expresses the physiology of the subject, to start from their peripheric extremity, since sensation precedes motion, and impression, reaction." Page 60.

Burdach adds, p. 216: "In following the nervous system from its peripheric extremity towards its central points, I may seem to be seeking for singularity. It will be said that I have reversed well-known things to give them an appearance of novelty. My manner of considering the nervous system of the trunk, is founded on the general principle, that *unity* is the essence of sensibility, and that, to comprehend the *origin the genesis of the soul*, we must proceed from the circumference, and stop at the centre.... The nervous system of the trunk is a network, and in order that intuition should not stop in this network, we must seek for the points, where the commencement is subject to no doubt. But where could this take place, if not in the peripheric extremities? It is only by starting from these, that we uninterruptedly acquire a general knowledge. But if we begin at a plexus, the cœliac for example, it is a matter of chance altogether, and we can give no reason why we should not rather begin with the cardiac plexus or the plexus of soft nerves." And thus he heaps up, nonsense upon nonsense. I shall not attempt to expose all the false reasoning in the transcendant declamations and magnetic reveries of Burdach. It is enough for me, to have shown the noble origin of Serres's favorite hypothesis.

If it were the result of observation, there would be no need of hedging it about with so many arbitrary and contradictory propositions, many of which I might easily have destroyed. I will call the reader's attention to a few of them.

It is false, to say that the nerves proceed to the ganglions, instead of saying that they arise, or depart from them. It is, as if we should say, that the branches proceed to the trunk, instead of growing from it. While the substance of the cotyledons, the farinaceous, starchy substance of the seed, is still liquid and transparent, the germ is already formed, drawing its nourishment and its elements from this substance. As soon as the germ is developed by means of external influences, it is nourished by this same substance, which is used in the same degree that the germ with its radicles is buried in the earth, and its plumule ascends into the air. The starchy substance being exhausted, the shrunken cotyledon falls, and the plant is nourished from the soil and atmosphere. How does nature manage to form a tree, but by first accumulating at various points the substance called *cambium*, deposited between the bark and wood all along the trunk and branches. This cambium first forms a swelling, whence arise new radicles that are united below to the stem, and also a new plumule appearing under the form of an eye or bud, and which is developed into leaves, branches, flowers, &c. Thus, by one swelling to another, and one new formation to another, the tree enlarges and obtains its entire development, its head. Notwithstanding all these formations from the centre to the periphery, there is not the less a retrograde action established in the branches and leaves. The leaves, composed of veins and parenchyma, absorb the nutritious substances of the atmosphere, which are distributed to every part of the plant. Here then are the same laws of formation which we see in the nervous system.

It is false, that Cuvier exploded the opinion, that the olfactory nerve takes its origin from the corpora striata. Before the publication of our memoir, Cuvier still derived the olfactory nerve from the corpora striata, and the optic, from the thalami. He even maintained with Jacobson, that the olfactory nerve, extremely

small, exists in the Cetacea, so that, since the cetacea have the corpora striata, he could not infer from this fact, as Serres says he did, that the olfactory nerve does not originate from them.

It is false, that in man, the external root of the olfactory nerve, is inserted as Serres expresses it, p. 291, by one of its bundles, on the outer rays of the anterior commissure. This commissure has no connexion at all with the olfactory nerve; for, it begins with the converging bundles of the middle lobes, traverses the anterior-inferior part of the corpora striata, without giving to, or receiving a single filament or bundle from the olfactory nerve.

It is false, that the olfactory nerves and the fifth pair increase in volume as that of the brain decreases, as Serres says. If it were so, the horse, ox, &c. ought to have a brain much smaller than the tiger and lion; the sheep's should be smaller than the cat's; the mole's much smaller than the rat's, &c. In one word, all that Serres parades so pompously about the proportions of the different parts of the nervous system, varies in respect to individuals, age, and variety of species. The only determinate proportions are between the integrant parts of a special division. For example, there is a proportion between the restiform bodies of the cerebellum, and the annular protuberance; between the pyramids, peduncles, optic thalami, corpora striata, and hemispheres.

It is false, that in the olivaria, the white matter is developed before the gray. If, as Serres says, p. 564, the gray substance is not developed in birds, fishes, and reptiles, it is because the olivaria and the nervous bundles that arise from them, do not exist in these animals.

In general, every thing that Serres has advanced, to prove that the white substance is formed before the gray, is arbitrary, contrary to the established laws of the organization of the nervous system, and, considering his disposition and intention, I venture to say, contrary to his own conviction, at least, without any positive proof drawn from nature itself.

It would require a work as large as Serres's, to refute in detail, all his erroneous assertions, without mentioning what he has borrowed, without acknowledgment, from Oken, Carus, Tiedemann, Burdach, Meckel, Treviranus, Arsaky, and finally from ourselves.

Let us look at the extracts inserted in the *Archives generales de Medicine*. The writer has faithfully copied Serres's propositions, without suspecting their error. He particularly insists on the following: "The question of the preëxistence of the different parts of the nervous system, is embraced in that of the preëxistence of its different arteries, and the order of their formation indicates the course of the development of the encephalon and spinal marrow."

This is very much as if I should say, the preëxistence of the different parts of the tree, is embraced in that of the preëxistence of the bark, and the order of its formation indicates the course of the development of the branches, &c. Undoubtedly, before an organ begins to exist, the parts which are essential to it do not exist. We may say with just as much reason, that the existence of the arteries is dependent on the existence of this or that organ.

As Serres and his reviewer make the arteries and nervous system, proceed together and in the same order, he seems to have forgotten to prove, that the formation of the arteries is also from the pheriphery to the centre.

Conclusion.

Thus have I brought forward and refuted all the most important objections, that modern anatomists and physiologists have urged against the reality of my anatomical and physiological discoveries. I have proved;

That the fate of the physiology of the brain is in-

dependent of the truth or falsity of my assertions relative to the laws of the organization of the nervous system, in general, and of the brain in particular, just as the knowledge of the functions of a sense is independent of the knowledge of the structure of its apparatus;

That the pulpy, non-fibrous, gray, cortical substance, is anterior to the white, fibrous substance, which takes its origin from the former;

That the different nervous apparatus, and the different parts of the brain, are each appropriated to a particular specific function;

That one nerve or cerebral part can never take the place, or function of another nerve, or cerebral part;

That it is absurd and contrary to the clearest indications of nature, to maintain, that the smallest part whatever of the brain or nervous system, may be sufficient for the different functions belonging to the different nerves and cerebral parts;

That it is impossible for the different parts, that constitute successively the brains of the lower animals, to form, in the human brain, with its peculiar cerebral parts, a single organ, a centralization of all the organs into one unique, indivisible organ, performing, as a whole, the most varied and essentially different function;

That the notions about the *unity* and *homogeneousness* of all the parts of the nervous system, were begotten by the speculative philosophy of Germany;

That the partisans of this chimera, while proclaiming this unity and homogeneousness, prove, themselves, the universal isolation, independence, and specific difference of the different parts of the nervous system, and the special nature of their functions;

That the experimental physiologists, in order to obtain pure and exact results, require the isolation of the parts on which they experiment, as an indispensable condition, and that, while they proclaim the unity and homogeneousness of all these parts, they

consider the isolation of lesion and mutilation, and consequently, also of the result, as impossible, since, they admit, that a part being wounded or irritated, wounds or irritates all the rest.

That it is in fact impossible to prevent the reciprocal influence of the different parts of the nervous system, or to isolate irritations, lesions, and mutilations, and obtain specific, isolated results;

That it is impossible to perform exactly the same operation, or experiment, a second time, and that not only each different experimenter, but the same man, in each new experiment, must necessarily obtain different results;

That it is absurd to think of applying the vague, arbitrary, varying and perhaps, poorly observed results of experiments on hens, pigeons, and rabbits, to the moral and intellectual faculties of man;

That it is repugnant to the organic laws, to lay down as a general law, the formation of the nervous system from the periphery to the centre, and that this extravagance is a spoilt child of the speculative philosophy of the mystic soil of Germany, &c. &c. &c.

In all my demonstrations and refutations, I do not so much rely on my own reflections, as on the confessions and imprudent falsehoods with which the works of my opponents are filled.

Memoires du Docteur F. AUTOMARCHI, ou les derniers momens de Napoleon, T. II, p. 29.

Here again are some passages directed against my discoveries, and which are interesting, more from the source whence they come, than from any intrinsic merit.

"Lady Holland had sent a box of books, in which was also contained a bust in plaster, the head of which was covered with divisions and figures, according to the craniological system of Dr. Gall. 'There, doctor,'

said Napoleon, 'that lies in your province; take and study it, and you shall then give me an account of it. I should be glad to know what Gall would say of me if he felt my head.' I immediately set to work; but the divisions were inexact, and the figures misplaced, and I had not been able to put them to rights, when Napoleon sent for me. I went, and found him in the midst of a mass of scattered volumes, reading Polybius. He said nothing to me at first, and continued to run over the pages of the work he held in his hand; he then threw it down, came to me, and taking me by the ears, and looking me steadily in the face, 'Well! *dottoraccio di capo Corso*, you have seen the bust?—Yes, sire.—Meditated the system of Gall?—Very nearly.—Comprehended it?—I think so.—You are able to give an account of it?—Your majesty shall judge.—To know my tastes, and to appreciate my faculties by examining my head?—Even without touching it (he began to laugh).—You are quite up to it?—Yes, sire.—Very well, we shall talk about it when we have nothing better to do. It is a *pis-aller*, which is just as good as any other; and it is sometimes amusing to notice to what extent folly can be carried.' He now walked up and down, and then asked, 'What did Mascagni think of these German reveries? Come, tell me frankly, as if you were talking to one of your brethren.—Mascagni liked very much the manner in which Gall and Spurzheim develop and point out the different parts of the brain; he himself adopted their method, and regarded it as eminently fitted for discovering the structure of this interesting viscus. As to the pretended power of judging from protuberances, of the vices, tastes, and virtues of men, he regarded it as an ingenious fable, which might seduce the *gens du monde*, but could not withstand the scrutiny of the anatomist.—That was like a wise man; a man who knows how to appreciate the merit of a conception, and to isolate it from the falsehood with which charlatanism would overcharge it;

I regret not having known him. Corvisart was a great partisan of Gall; he praised him, protected him, and left no stone unturned (*fit l'impossible*) to push him on to me, but there was no sympathy between us. Lavater, Cagliostro, Mesmer, have never been to my mind; I felt, I cannot tell how much aversion for them, and I took care not to admit any one, who kept them among us. All these gentlemen are adroit, speak well, excite that fondness for the marvellous, which the vulgar experience, and give an appearance of truth to theories the most false and unfounded. Nature does not reveal herself by external forms. She hides and does not expose her secrets. To pretend to seize and to penetrate human character by so slight an index, is the part of a dupe or of an impostor; and what else is that crowd with marvellous inspirations, which pululates in the bosom of all great capitals? The only way of knowing our fellow-creatures is to see them, to associate with them frequently, and to submit them to proof. We must study them long, if we wish not to be mistaken; we must judge them by their actions; and even this rule is not infallible, and must be restricted to the moment when they act; for we almost never obey our own character; we yield to transports, we are carried away by passion; such are our vices and virtues, our perversity and our heroism. This is my opinion, and this has long been my guide. It is not that I pretend to exclude the influence of natural dispositions and education; I think, on the contrary, that it is immense; but beyond that, all is system, all is nonsense."

Already, in the *Mémorial de Saint Hélène*, by the Count Las Casas, the following passage had appeared:—

"I have greatly contributed to put down Gall; Corvisart was his great follower; he and his fellows had a strong leaning to Materialism; it would increase their science and their domain. But nature is not so poor; if she was rude enough to announce her meaning by external forms, we should soon attain our ends,

and we should be more learned. Her secrets are finer, more delicate, and more fugitive; — hitherto they have escaped every one. A little hunchback is a great genius; a tall and handsome man is often a great ninny; a large head with a big brain, sometimes has not an idea, while a little brain is often in possession of vast intelligence. And yet, think of the imbecility of Gall; he attributes to certain bumps, dispositions and crimes which are not in nature, and which take their rise from the conventional arrangements of society. What would become of the bump of thieving if there was no property? of the bump of drunkenness, if no fermented liquors existed? of that of ambition, if man did not live in society?"

Sovereigns are always deceived when they ask advice from the ignorant, the jealous, the envious, the timid, or from those who, from age, are no longer accessible to new opinions. Napoleon acquired his first notions of the value of my discoveries, during his first journey to Germany. A certain metaphysical jurisconsult, E——, at Leipzig, told him, that the workings of the soul were too mysterious to leave any external mark. And, accordingly, in an answer to the report of the Institute, I had this fact in view when I terminated a passage by these words: — "And the metaphysician can no longer say, in order to preserve his right of losing himself in a sea of speculation, that the operations of the mind are too carefully concealed, to admit of any possibility of discovering their material conditions or organs." At his return to Paris he scolded sharply (*tança vertement*) those members of the Institute, who had shown themselves enthusiastic about my new demonstrations. This was the thunder of Jupiter overthrowing the pigmies. Immediately, my discoveries became nothing but reveries, charlatanism, and absurdities; and the journals were used as instruments for throwing ridicule — an all-powerful weapon in France — on the self-constituted bumps. Napoleon was made to believe that "Gall's

imbecility" had led him to imagine a bump or organ for drunkenness ; and in this case I certainly should have merited this laconic epithet. "*He attributes to certain bumps, dispositions and crimes, which are not in nature, but arise from the conventional arrangements of society.*" And whence does society arise ? If Napoleon had read all that I have said in this work on society, on the social life of man and animals, and on the pretended artificial qualities and faculties, he would have acquired profounder views of all these objects. In regard to my doctrines, the ideas and prejudices of Napoleon differ in no respect from those of the vulgar. *What would become of the bump of thieving, if there was no property ? of that of ambition, if there was no society ?* What would become of the eye if there was no light ? — but light exists. What would become of taste and smell, if there were no odorous particles, and no savory qualities ? — but these qualities and particles exist. What would become of the propensity to propagation, if there were not two sexes ? — but two sexes exist. What would become of the love of offspring and of children, if offspring and children did not exist ? — but they do exist. What would become of the carnivorous instinct, if animals did not exist to be devoured ? — but these animals do exist. In the same way, property and society exist in nature, as I have already proved in treating of these subjects. I conclude, then, that neither Napoleon nor his advisers had penetrated sufficiently far into the nature of things, to perceive that the organization of man and animals, is calculated for and adapted to the existences of the external world, and that we have no connexion with external objects, except in so far as we have received organs which are in relation and in harmony with these same objects ; and that, whenever any given organ is wanting, the thing in relation with that organ, has no longer an existence for such an individual.

"If Napoleon wished to destroy the tendency to

materialism in the way he understood it, he ought to have begun by prohibiting the study, not only of the anatomy and physiology of the brain, but also that of natural philosophy, natural history, of the influence of nourishment, of the seasons, climate, and temperament, upon the character of man, &c. &c. And after having ordained it to be taught, that the eyes and ears were not necessary for seeing and hearing, nor the brain for thinking, he ought to have employed three hundred thousand bayonets, and as many cannon, to render the functions of the mind absolutely independent of matter. This victory once promulgated and acknowledged, he would easily have put down the anatomy and physiology taught by a feeble son of Esculapius. But coffee is swallowed, potatoes are eaten, and vaccination is performed, without regard to the outcries of some physicians against them; the blood circulates in spite of Gassendi; the earth revolves in despite of the anathema of the Pope; animals are no longer automata, notwithstanding the decrees of the Sorbonne, and the anatomy and physiology of the brain, discovered by the German doctor, subsist and will subsist in spite of the efforts of Napoleon, and of his imitators, and of all their auxiliary forces.

M. Antommarchi had but a very meagre and superficial knowledge of the physiology of the brain, and was not at all prepared to rectify the prejudices of his august patient. After the fashion of superficial and officious ladies, a plaster-bust, with the organs marked on it, was sent like a play-thing to Napoleon. But it was quite above an ordinary conception to send him my work, or to ask him to become acquainted with my own ideas. In this way the emperor and his physician continued, in the midst of their amusement, to be ignorant of the principles and tendency of the physiology of the brain. M. Antommarchi amuses his readers with a vague enumeration of the organs of which he perceived the indications in Napoleon. He found the organs of Dissimulation and of Conquest,

which last is apparently my organ of the Carnivorous Instinct; the organ of Benevolence; that of Imagination, which is not to be found in my work; and the organs of Ambition, of Individuality, of Locality, of Calculation, of Comparison, of Causality, or the inductive spirit.

Let us now give the final result of our observations,—the true theory of the moral qualities and intellectual faculties of man.

PHILOSOPHICAL CONSIDERATIONS.

ON THE MORAL QUALITIES AND INTELLECTUAL FACULTIES OF MAN.

Philosophy of Man.

IN the course of this work, I have often said that my predecessors never succeeded in making discoveries on the functions of the brain in general, nor of its particular parts, because they suffered themselves to be guided by a false philosophy of the human qualities and faculties. This censure is applicable, not only to the doctrines of this or that philosopher, but is deserved equally by all. I have promised to substantiate the charge, and have already done so, in several places, particularly in vol. I. Now that the reader is familiar with the real fundamental powers, I consider him sufficiently prepared to follow me step by step in the following considerations.

I shall not introduce the systems of my predecessors, in order to refute them by a comparison with mine, for it would be idle to fight with darkness. It will be sufficient for me to bring in light. I shall here assemble some ideas that are scattered over this work, and

shall show the reader the consequences, that necessarily result from them, and which he may already have inferred for himself.

Of the Difference between the Fundamental Powers and their General Attributes.

The term, *fundamental quality or faculty*, expresses what is proper or peculiar to the powers, — that which constitutes their essence, their nature. The term, *general attribute*, on the contrary, expresses what these fundamental qualities and faculties have in common.

I have proved, that all the qualities and faculties of which I have treated, and whose organs, I have discovered, are primitive fundamental powers. But none of my predecessors were acquainted with these powers, which are exclusively the functions of the particular cerebral organs. No one ever sought for an organ of the instinct of propagation and of the love of offspring, of the carnivorous instinct, of benevolence, of music, of calculation, &c., consequently, none whatever were discovered. They confined themselves to those phenomena that are common to the fundamental powers, viz., their general attributes. They sought for the organs of attention, perception, memory, judgment, imagination, appetite; of instinct, affections, and passions. Reason and will were with them, the pure powers of the mind, independent of every organic condition. I shall now proceed to prove that attention, memory, judgment, and imagination, are only attributes common to the fundamental qualities and faculties, not the fundamental qualities and faculties themselves.

The better to connect the philosophy of man with natural history generally, let us glance at the world of nature, and examine the methods that naturalists have always adopted, for studying its details. They

have begun by trying to ascertain the general attributes of all bodies, and have discovered that extent, impenetrability, attraction, and repulsion, belong to all material things,—to light, as well as to metals, to the integrant parts of a plant, as well as those of a man. But if natural philosophers had contented themselves with the knowledge of these general properties, what should we now know of their science? Could we distinguish, by any specific character, the most dissimilar substances, such as earth, water, air, metals, light, plants, animals? for, they are all endowed with extent, impenetrability, attraction, and repulsion. It was necessary to look for particular characters, and to distinguish bodies into classes, and, it is by means of these characters, we distinguish earth from water, water from metals, and plants from animals, and thus a great step is made. But, if they had confined themselves to the properties common to all metals, to all plants, &c., the natural sciences would not now be in existence. The object is, to distinguish one metal from another, one plant from another, &c., that is, to find the properties that distinguish a certain class of metals, plants, and animals. They have talked of terrestrial animals, and aquatic animals, of insects, fishes, reptiles, amphibia, and mammifera; and the more they have abandoned those general expressions, the more they have concerned their minds with particular properties. They have established subdivisions; divided mammifera into frugivorous and carnivorous; the carnivorous, they have subdivided into cheiroptera, galeopthei, insectivora, carnivora, &c., and the more they have succeeded in establishing characters, that are applicable only to particular genera and varieties, the more precise, clear, individual, and consequently useful, does the knowledge of the naturalist become.

Why is it, that it is precisely those who are so proud of the metaphysical spirit of their inquiries, who publish the results of their speculations with as

much assurance, as if they were demonstrated truths, that reject this method, and think their notions the more precise, the more general they are; or in other words, the less applicable they are, to particular cases and individual facts, and consequently, the less practicable? It is probably because the methods of these philosophers has required no observation, that it leaves the field entirely open to sophisms, as well as to sound reasoning, and that in this way, each metaphysician can easily erect a system of his own, and become the chief of a sect. But it necessarily results, that these doctrines have nothing in common with the real world; that they all are stamped with the peculiar turn of mind and capacity of their inventors; that they differ, as much as the minds of those that conceived them. In entering upon this subject, I shall begin to show the faults of the existing philosophy, relative to the higher functions of animal life, or the moral and intellectual powers.

The most general property, that which is common to all the nerves, is sensibility, or power of perceiving irritations, stimuli, &c., or to use another term, sensations. Are there not philosophers, even in our days, that admit only this single, solitary power in the animal kingdom? that derive from it, the voluntary movements, the functions of the five senses, and all the moral qualities, as well as intellectual faculties? To think, say the ideologists, is to feel; to remember, judge, and all that, is only to feel. All the faculties of the understanding are included in the faculty of feeling, and the difference of motion alone, according to M. Destut-Tracy, explains all the different modes of feeling.

There can be no doubt that sensibility bears a part in all these phenomena, in the same way that all bodies are endued with impenetrability and extent. But what does physiology gain by knowing that the nerves are sensible? Does this throw any light on the true cause, on the material conditions of specific

functions, on voluntary motion, on the functions of the five senses, on the different moral qualities and intellectual faculties? Would we listen to a naturalist who should tell us that all beings are only bodies differently modified? that insects, fishes, amphibia, and mammifera, are only animals differently modified? According to this system, the study of natural history, would be an easy work. But how do the modifications of these sensations arise? How are these different motions effected? How does the general faculty of feeling become the faculty of voluntary motion, of seeing, hearing, and feeling? How does it become this or that intellectual faculty, or moral quality? Could not the Author of all that exists, create a particular family of nerves for voluntary motion, another for the functions of the five senses, and another still, for each function of the qualities and faculties? Was it not necessary that the nerves of each sense should have their peculiar origin, structure, and function? True indeed, there is sensation in all these phenomena, but it is something more than sensation modified in different ways. It is sensation essentially different, in each different case—as essentially different, as the plant is from the animal, the mammifera from the bird. The end of physiological researches, is, to ascertain the difference between sensations, and to discover the different organs which nature has created in the system, for producing so many essentially different sensations, from the most simple perception of a stimulus, even to the most elevated conceptions. It is clear, therefore, that this mode of generalization, cannot reach objects as they exist in nature. We shall see that it is the same with the other faculties, which the ideologists have recognised as the only intellectual faculties, and that they equally, are only common attributes of all the fundamental faculties,

*Of Perception, Recollection, Memory, Judgment,
Imagination, and Attention.*

To prove that the faculties of the mind, hitherto admitted by philosophers as realities, are only the attributes of each fundamental faculty, I shall content myself with some examples which, it will be easy for the reader to apply to himself.

I class among the number of fundamental faculties, the sense of locality, the sense of tones, the sense of numbers, and the sense of arts. Now, he that is endowed with the sense of locality, the sense of tones, &c., necessarily has the faculty of perceiving the relations of space, and of tones, and the same may be said of the sense of numbers. A person endowed with the sense of locality, remembers the relations of space, and the places he has seen, when he meets them again. He even enjoys the faculty of presenting to his mind, by its own inward power, the relations of places which he has seen, without its being necessary for the outward impression to be repeated; that is, he is endowed with the memory of places. He too who remembers having heard certain music, has a musical memory; and he who can reproduce, by an inward power alone, certain music which he has heard, and without needing a renewal of the outward impression, has also a musical memory. In the same way, the arithmetician and mechanic have a memory of the relations of numbers, and of the arrangement of a machine.

To these four fundamental faculties, therefore, belong four faculties of perception and four of memory. The faculty of perception and that of memory are common to these four, and to all the fundamental faculties in general. None of these common attributes constitutes a fundamental power. An animal may have the faculties of perception and memory, relative to the sense of tones and the sense of localities, for

example, without having the faculty of perception, or memory, in regard to the sense of numbers or that of mechanics, because he wants these two fundamental faculties. When the fundamental faculty is wanting, the attributes must be also. The dog, endowed to such an astonishing degree, with the sense of locality, has neither the faculty of perception, nor that of memory, for the relations of tones, for the structure of a machine, or for moral and religious thoughts. The beaver which is an admirable architect, has neither perception nor memory of the relations of tones and colors, and for the reason, again, that he is destitute of two fundamental faculties, the sense of tones and that of colors.

From what has been said, it is very evident, that perception and memory are only attributes common to the fundamental faculties, but not the fundamental faculties themselves; and consequently, that they can have no proper organs. They therefore, that seek for such organs, will never succeed in finding them. In fact, if the perceptive faculty were a fundamental power, and had its peculiar organ, the man or brute endowed with it for one thing, would be so for all things. But natural history proves the contrary in the different species of brutes, and in partially imbecile men; and it is precisely the same with memory. Neither man nor brute can remember objects, which they have no capacity to receive.

If perception and memory were fundamental forces, there would be no reason why they should be manifested so very differently, according as they are exercised on different objects. There would be no reason why the same, and, in fact, every individual, should not learn geography, music, mechanics, and arithmetic, with equal facility, since their memory would be equally faithful for all these things. But where is the man, who, after the greatest possible application, should succeed with equal ease, in these different branches of knowledge, and not evince,

however astonishing his capacious memory, in certain respects, might be, an extremely small endowment of the same faculties, in all other respects?

All that has been said, relative to the common attributes of all the fundamental faculties, is also applicable to judgment and imagination. Whoever is eminently endowed with the sense of locality, easily recognises the relations of places, and has a good judgment of the relations of space. Whoever is endowed with a very active sense of tones, perceives concords, readily judges of the correctness, or incorrectness of the relations of tones, and finally, has a good judgment of the relations of tones. In the same manner, whoever has the sense of numbers, has a good judgment of the relations of numbers; the sense of arts, a good judgment of works of art. When, however, the fundamental faculty fails, the judgment relative to the objects of this fundamental faculty, must necessarily fail also.

I apply the term, imagination, to the action of whatever faculty it may be, that takes place independently of the external world; it is the creative power of each fundamental faculty. The imagination of the sense of locality creates landscapes; that of the sense of tones, music; that of the sense of numbers, problems; and that of the mechanician, machines. This explains why a man's judgment may be prompt and correct, relative to certain subjects, while he is almost imbecile in regard to others; why he may manifest the most rich and brilliant imagination, relative to a certain class of subjects, while he is cold and barren, upon every other. It is impossible for an animal to possess judgment and imagination respecting subjects, for which nature has refused the fundamental faculty. What judgment of music or the relations of numbers, could be pronounced by the fox, which, nevertheless, is an admirable judge of the means of escaping from snares and surprising his prey; or by the beaver, which judges of the rise and fall of the

stream, and accommodates his structure to these circumstances? The dog, by virtue of his imagination, dreams, that he is engaged in the chase, or, that he has lost his way, and wanders through the whole city in search of his master's house. But will you believe, that he dreams of mechanics, pictures, calculations, architecture, and combinations of philosophical ideas? Judgment and imagination, therefore, are not fundamental powers, but only attributes common to all the fundamental faculties. Is it a matter of astonishment, then, that they have sought in vain for their organs?

I cannot conceive, how it ever entered the heads of certain philosophers to maintain, that attention is the source of all our faculties and propensities. I admit, for a moment, that attention is exerted in every thing done by man or brute; but it must proceed from a fundamental power,—it never can be the source of any fundamental power whatever. A partially imbecile person may give the most untiring attention to every thing relative to mimicry, to order, and to the sexual functions, but none whatever to sentiments and thoughts of a different order. The educated and thinking man is very soon fatigued, when fixing his attention on subjects that are out of his sphere, while it is mere sport for him, to give unwearied attention to subjects that belong to his province. He, who is highly endowed with a sense of locality, devotes his attention, without an effort, to the relations of space; while, if his sense of tones be feeble, he will hardly be aware of the performance of the most enchanting music. Vaucanson, while a child, gave his attention to the wheels of a time-piece, on which a musician, or gray-haired poet would have scorned to give a single look. The coquette, whose whole attention is engrossed by the milliner's shop, would pass by the most valuable collection of natural history, or the richest library, with perfect indifference. Attention, therefore, is only an attribute of each fundamental faculty, and when this is wanting, attention to the

objects of this faculty, is impossible. Try to fix on numbers, colors, or a poem, the attention of a falcon, which keeps his eye on the lark; of the horse, whose ear is trained to obey the orders of his keeper; of my starling, which forgets to eat its favorite meal of worms, when I am whistling it a tune.

The reader, I think, from what has been said, must be convinced that the intellectual power, with all its subdivisions, such as perception, memory, judgment, and imagination, are not fundamental faculties, but only their general attributes. As the fundamental faculties are not known; as the organs of their attributes alone, have been sought for, I have good reason for saying, that a false philosophy has impeded the progress of the discovery of the functions of the brain, and its integrant parts.

In recapitulation then, we observe, that wherever there exists a fundamental faculty, a particular and definite intellectual power, there also necessarily exists a power of perception relative to this faculty. Whenever this faculty is actively exercised upon its appropriate objects, there is attention. Whenever the ideas or traces, which the impressions of these objects have left on the brain, are renewed, either in the presence, or absence of these same objects, there is passive memory, reminiscence. If this same renewal of impressions is done by a deliberate, voluntary act of the organs, there is active memory. Whenever an organ or fundamental faculty, compasses and judges the relations of analogous and different things, there is judgment. A series of comparisons and judgments, constitute reasoning. Whenever an organ, or fundamental power creates, by its own inherent energy, without the concurrence of the external world, objects relative to its function; when the organ, by its own activity, discovers the laws of objects placed in relation with it in the external world, there is imagination, invention, genius. Admitting, for a moment, that perception, attention, memory, reminiscence, comparison, judg-

ment, reasoning, imagination, invention, and genius, considered either as gradations of the different degrees of the same faculty, or, as particular states of this same faculty, it still remains certain, that all the fundamental faculties, that have been demonstrated as such in Vols. III, IV, and V, are, or may be, endowed with perception, attention, memory, judgment, imagination, and consequently must be recognised as intellectual and fundamental faculties; while the pretended mental faculties of my predecessors, are only common attributes. Here, then, is an entirely new philosophy of the intellectual powers, founded on the natural history of the different modes of human intelligence. Let us apply the same operation, to the appetites, faculties, or qualities.

Of the Moral Qualities, the Appetitive Faculty, the Appetites, Propensities, and Passions.

The appetitive faculty, and its subdivisions, have been considered as proper faculties, in the same manner as the intellectual faculty and its subdivisions, and their organs have also been sought for. But, as they have never succeeded in finding them, they have concluded, from all these fruitless researches, that the operations of the mind are much too secret, for it to be possible to follow their traces. The discovery of these organs was in fact impossible; for, desires, propensities, passions, are, in fact, only different degrees of the activity of some fundamental power, whether intellectual or appetitive. A desire, propensity, or passion, supposes, therefore, a fundamental quality or faculty, and we can have no desire, propensity, or passion, but in regard to objects, for which we are endowed with a primitive or fundamental power. Let me explain. When a person is endowed with a sense of poetry, of construction, of locality, in a feeble degree only, there will not be a well-marked fondness for these objects.

When, on the contrary, the organs of these fundamental powers act with more energy, the person finds a pleasure in the exercise of the functions that relate to it; he has a propensity for these objects. When the action of these organs is still more energetic, the person feels a necessity for occupying his mind with these objects, — he has a *desire* for such occupation. Finally, if the action of these organs preponderates over the rest, he is drawn towards these objects; he feels his happiness in them; he feels opposed and unhappy, when he cannot follow the bent of his propensity; he has a *passion* for these objects. In the same manner, certain persons have a passion for music, poetry, architecture, travelling, &c.

As the fundamental powers are developed in different proportions in each individual, a person may have a violent passion for certain things, music, for instance, and be very indifferent to others, mathematics for example. If there were an organ of the passions, those endowed with it, should have an equal passion for every object. The same must be the case with the desires and propensities, if they are proper faculties or appetites, and also with the most exalted intellectual faculties. They, whose organ of comparative sagacity is very active, have a taste, a passion for comparisons and apologues. A great activity of the organ of metaphysics, immerses the thinker in the world of ideas. He sees no truth, and feels no pleasure, but in things that do not come under the cognizance of the senses — in speculation and abstraction. By the force of thought alone, he would divine, or rather construct, the laws of the universe. Who, too, at some time or other, has not been the victim of some epigrammatic friend? Who knows how much it costs a Boileau, or a Piron, to restrain the expression of his caustic humor? Prevent a Bacon, or a Leibnitz, from reflecting on the connexion of cause and effect, of drawing conclusions, and establishing principles, and you oppose their inclination — you do violence to their passion.

The gradation that takes place in the intellectual talents and faculties, is still more sensible in reference to those fundamental powers, that are only sentiments and appetites. While the cerebral organ of love remains undeveloped, there is no difference between the sexes, to the child. But, according as this organ is developed, the boy and girl begin to fix their attention on whatever relates to the sexual functions, whether in themselves or others; and, in the same proportion, there arises a sentiment, a propensity, which at last is raised to a passion. The same is true of the love of offspring, of self-defence, of the carnivorous instinct, of the sentiment of property, of pride, vanity, circumspection, &c. There are women passionately fond of children; there are persons, passionately benevolent, devout, or ambitious.

Let us now descend to beings, that want one or another of the fundamental powers, and we shall see, that it is impossible they should have a desire, a propensity, or passion for things, with the fundamental power of which, they are not endowed. But give to brutes the fundamental powers, and you have the dog passionately engaging in the chase; the weasel strangling the hens; the nightingale singing by the side of his female with such warmth of passion, as sometimes to sink under his long continued efforts; and the monkey affectionately loving his female and young; but in none of these creatures, can you give rise to the desire, propensity, or passion for devotion, mathematics, or metaphysical speculations. It is clear, therefore, that the desires, propensities, and passions, are not proper fundamental powers, but the result of the different degrees of the activity of the organs, or primitive qualities and faculties.

I have shown then, even in respect to the fundamental faculties, such as the sense of tones, of numbers, &c., which belong to the intellectual faculties, there is a desire, propensity, or passion, according to the degree of their activity. Not only so, but it must be

admitted that perception, memory, imagination, are also the attributes of the fundamental powers, that constitute the sentiment. The instincts of propagation, of love of offspring, of pride, and of vanity, possess indisputably their own perception, memory, imagination, and judgment. In this respect, the sensations and sentiments are affected, like the thoughts produced by the intellectual faculties. The history of insanity and idiotism proves to us, that when one of the fundamental qualities has been lost or enfeebled, its perception, memory, judgment, imagination, attention, all its attributes in short, are equally lost or enfeebled.

I have mentioned cases, where, in consequence of some accidental lesion of the cerebellum, the sexual parts were completely atrophied, and the generative faculty entirely lost. Now, in these cases, the memory of past enjoyment is as feeble as the desire. These individuals talk on the subject with indifference, and it is more from what they have said, than from any impressions they retain, that they know they were once like other men, and, it is to be presumed, that if the cerebellum had entirely lost his action, the memory of the sensations formerly experienced, would be completely gone. I have also related cases, where the total loss of an external sense, and of its internal nervous apparatus, has not only prevented new impressions from taking place, but has effaced the old ones relative to this sense; and why should not the same thing happen, where there is a total loss of the activity of an organ of a moral quality, or intellectual faculty? However this may be, it remains certain, that desire, propensity, and passion are only degrees of the action of fundamental powers, and that it is wrong to consider these degrees, as so many real powers. Consequently, I have substantiated my charge against the philosophy of my predecessors. May the refutation of these errors, consecrated by time, show how useless is all reasoning, unsupported by facts.

Of Instinct and Understanding, Intellect, or Intelligence. Have they particular Organs?

The brute acts from instinct, man from understanding, — such is the language of philosophers. In the former, say they, instinct supplies the place of intelligence, which is peculiar to man. But do they act solely from instinct? are they destitute of intelligence? Is man exempt from all instinctive impulses, and beyond the influence of instinct?

We have only to obtain a precise idea of instinct, and of understanding or intellect, and the truth will spontaneously present itself to our minds. Instinct is a sentiment, an inward movement, independent of reflection and volition, — an impulse that impels a living being to certain actions, without its having a distinct idea of the means or end. I now ask, if instinct is a universal power, that explains all the actions of brutes, or whether it varies as much as the fundamental qualities and faculties, and produces only the manifestation of these qualities and faculties? If instinct be a universal power that explains all the actions of brutes, how is it connected with organization? Has it a proper organ? If instinct were a universal power, every animal would do precisely like the rest, and no one would be unprovided with it; the species that makes a web, or constructs hexagonal cells for the reception of its honey, would also sing, or manifest attachment to its master. The spider by means of its web, preys upon flies; the working-bee constructs cells, but kills no flies for food; it tends the young, but has no connexion with the males. Many male animals perform their sexual duties, but take no care of the offspring. The male and female euekoo, both, abandon the care of rearing their young to other birds, though impelled to intercourse by a very ardent instinct. The beaver constructs its cabin, but neither sings nor hunts; the dog hunts, but does

not build; the speckled magpie sings, builds, and hunts; the quail prefers concubinage to marriage, but tends its young, and migrates; the partridge marries, and takes care of its young, but does not migrate; the wolf, fox, roe-buck, and rabbit, live in the marriage state, and both male and female concur in tending the young; the dog, stag, and hare, use the first female that comes along, and know nothing of their young. The ferocious wolf, and the cunning, timid hare, make no burrows, like the courageous rabbit and crafty fox. The rabbits live in a kind of republic, and place sentinels, but not so do the fox and hare. How can these instincts exist in one species of animals, and not in another? How can they be so differently combined?

If instinct were a single, general power, not only ought the instincts to be manifested all at once, but also in the same degree. The truth is, however, that while certain instincts act with great force in the young animal, they are completely inactive in others; certain instincts act at one season, others, at another season. There is one season for propagation, and another, for emigration; one, for living alone, and another, for assembling in flocks, or collecting provisions. And how are we, on the supposition of a general instinct, to explain why the different instincts, not only exist separately, in different species, but are, many of them, even contradictory? It is wrong to consider instinct a general power, and explain by it, all the actions of animals, however opposite they may be; and consequently, it is absolutely impossible to find a single, general organ of instinct, and accordingly the efforts made to find it, have been fruitless. Such expressions serve only to convey the appearance of knowledge, to get rid of all difficulties by means of an *occult faculty*, and to dispense with all laborious research.

Are there as many instincts as there are fundamental powers, and does the term *instinct* merely desig-

nate the activity of these same fundamental powers? Propagation, love of offspring, friendship, and attachment, marriage or celibacy, the social or solitary state, self-defence or love of fighting, preference of animal or vegetable food, providence for the future, circumspection and the precaution of placing sentinels, the choice of a fixed place of abode, emigration, singing, construction, &c., are derived from as many fundamental qualities, or primitive dispositions, and all become instincts from the moment, when, in consequence of their activity, they produce in the animal a desire, a want, an internal impulse, under the influence of which, it is impelled to act. The term *instinct*, therefore, applies to all the fundamental powers, and the instinct must have as many organs as there are fundamental powers. This explains very naturally, how an animal may be endowed with one instinct, and be destitute of another. In this sense, it may be said, that all animals act from instinct, though their acts are very different, and even opposite.

Let us now examine whether, in the manifestation of their fundamental powers, animals always obey a blind impulse? whether they act exclusively from impulse, or, are conscious of their propensities and faculties? whether they modify their instinct by a clear idea of the means or end to be used? in other words, must they be considered to possess *intelligence, understanding*? If animals acted only from a blind instinct, their manner of acting would be always uniform. Experience and external influences would never be able to make them deviate, one hair's breadth, from their ordinary routine; their actions and the order of their occurrence, might be submitted to calculation, like the course of a machine, (which, in fact, is the common doctrine;) but experience teaches a very different lesson. At the very moment the wolf scents the flock enclosed in the fold, the thought of the shepherd and the dog comes to his recollection, and counterbalances the present impression which he

receives from the sheep. He measures the height of the fold, compares it with his strength, judges of the difficulty of leaping over it with his prey, and concludes the attempt would be useless, or dangerous.

Yet, from the midst of the flock, when scattered over the field, he will seize a sheep, before the eyes of the shepherd, particularly if the nearness of the woods affords a chance of concealment. He undermines the park or sheep-fold, when he can find no other means of penetrating it. He needs but little experience, to learn that man is his enemy, and that he must fear his snares. Thus, he is always on his guard. The older he is, and the more dangers he has encountered, the more distrustful he becomes. Wolves will hunt in packs, and the mutual aid they afford, renders the chase easier and surer. If a flock is to be attacked, a female goes and shows herself to the dog, which she leads away in pursuit of her, while the male leaps over the fold and carries off a sheep which the dog is unable to protect. In pursuing a deer, the duty is divided according to the strength. The male watches and attacks the animal, chases and puts it out of breath, when the female, which is placed somewhere ahead, renews the chase with fresh strength, and in a little time renders the contest very unequal. It is easy to entrap a young inexperienced fox, but if he has learned the ways of man, the same means will be useless. No bait can then induce reynard to brave the danger, which he discovers or suspects. He scents the iron in the trap, and this sensation, already terrible to him, predominates over every other impression. If he perceives that snares are multiplying around him, he quits the country for a safer one. Sometimes even, emboldened by gradual and repeated approaches, and guided by his smell, he will find means, safely to himself, of stealing the bait from the trap. Man, with all his intelligence, needs a great deal of experience, not to be baffled by the prudence and cunning of the fox.

When the stag has been often disturbed in his retreat, he conceals himself by an artifice, which can only be the fruit of nice view and deep reflection. He frequently will change his thicket so as to accommodate his location to the wind, in order that he may be aware of whatever may menace him from without. Frequently, instead of confidently returning and going straight to his lair, he will do so only in appearance; and enters the wood, comes out, goes away, and returns upon his track, repeatedly. Without any cause of present disturbance, he uses the same artifices, that he would use to escape from the pursuit of dogs, if he perceived himself chased. I have elsewhere mentioned the means, made use of by stags and hares, to elude the pursuit of the hunters and dogs. Every hunter also knows, how easy it is to surprise these creatures, in countries where they are not ordinarily disturbed; but the moment they have learned from experience, the dangers that threaten them, the hunter finds it necessary to multiply and vary his means.

We have daily opportunities of seeing the difference between a trained and an untrained horse, and the changes, which education effects in the manners of dogs. Whoever has, in the slightest degree, observed animals, must concede to them a certain degree of perfectibility, of which I have mentioned a great number of examples in this work. It cannot be denied, that they remember past facts, and that their conduct is regulated in reference to them; that they compare, reflect, and judge; and that in emergencies they take measures well adapted to the circumstances. All this cannot be the impulse of a blind instinct,—it must be admitted, that, to a certain extent, they are endowed with understanding. But as this understanding is only the faculty of modifying the manifestation of their natural instincts, according to accidental circumstances, it follows, that there is a portion of understanding peculiar to each species, and in virtue of this law,

each species remains confined to the circle in which nature originally enclosed it. Still, it is established that animals exercise their faculties with more or less intelligence, or understanding. Now let us inquire whether man also, acts from instinctive impulses, or exclusively obeys the dictates of reason? Is he the author of his propensities, or are they as involuntary in him, as in the brute?

I do not speak of those automatic movements, that some authors confound with instinct, and which both man and brute do unconsciously, and without any possible premeditation. For instance, we recoil suddenly from the sight of a danger, and in falling, we stretch out our arms, either to come on our hands, or to preserve our equilibrium. I here speak of instinctive propensities,—true instincts. I have proved in the section on innate dispositions, and when treating of the fundamental qualities and faculties, that man neither invents nor creates his propensities and faculties. I know not to what degree of ignorance, are to be attributed the dogmas of that arrogant philosophy which pretends that man is beyond the reach of those laws, which govern the animal kingdom. When man burns with physical love and seeks a companion; when he loves his children and takes care of them; when he defends himself and family against his enemies; when he is proud, vain, benevolent, cruel, avaricious, cunning, and circumspect, who does not know that this takes place without his participation, or resolutions? Who does not perceive, that all these sentiments are movements, dispositions independent of reflection?

They are not the result of attention, of deliberate thought, of premeditation, of volitions. They are genuine instincts. The intellectual faculties also are, in most cases, exercised instinctively. Whenever the organs of these faculties have acquired considerable development, or have been excited by some kind of stimulus, they act involuntarily, without reflection, or

judgment. The child cuts out figures and builds, makes music, or poetry, seeks, in cats and mice, for the causes of the vital phenomena, &c., and all this too, from a blind internal impulse. So far are such individuals from being conscious of their faculties, that when their attention is called to them subsequently, they are astonished to find such extraordinary qualities or faculties. This instinctive action continues, in most men, more or less exclusively, for their whole life; but few persons ever obtain a clear knowledge of their propensities and faculties. The more violent the action of the organ is, the more imperious is the passion; the more brilliant the genius, the more instinctive the activity of the organ, at least in the early periods of its manifestation. My admiration was deeply excited by the following lines of Voltaire, who has achieved so much himself, by the force of instinct, addressed to Diderot, under date of 20th April, 1773.

"All the philosophers together could not have written the *Armide* of Quinault, nor *les Animaux malades de la peste* of la Fontaine, who was unconscious of what he had done. It must be granted that, in the performances of genius, all is the work of instinct. Corneille conceived and wrote the scene between Horace and Cornelius as a bird builds its nest, with this exception, that a bird always does its work well, which is not the case with us."

It is only, when man turns his attention to his innate internal powers, compares them with the powers of others, learns their use and how to employ them under change of circumstances, and reflects upon himself, that his instincts gradually acquire the character of intellect or understanding. To be endowed with intellect, or possess intelligence, is, in other words, to have a clear knowledge of one's propensities and faculties,—to feel and exercise them with attention. There are, therefore, as many different kinds of intellect, as there are distinct qualities and faculties.

One individual may have considerable intellect, relative to one fundamental power, but a very narrow one in reference to every other. Man, by reason of more and nobler organs, is much more capable than the brute, of acquiring a clear knowledge of his propensities and faculties; and, in consequence of this prerogative, he is endowed with intellect, not exclusively, but in a higher degree than any other animal. To concede to the brutes, what God has given them, is surely not to degrade our own species.

From what has been said, we draw the conclusion, that an organ of intellect or understanding, is as entirely inadmissible, as an organ of instinct.

Of Reason, Will, and Free-Will. Have they particular Organs?

Reason is to the intellect or understanding, what the will is to the propensities. Let me explain. In the section on innate dispositions, I have explained the difference between propensities, will, and liberty.* Desire, propensity, and passion are different degrees of the activity of each fundamental power. Oftentimes man is incapable of controlling the violent action of some one of his organs; in which case, the desire, propensity, and passion that results, are involuntary; and thus arise temptations, which are the first conditions of vice and virtue, because, while we only *desire*, we deserve neither punishment, nor reward. Most often, the brutes have only desires without will, and the same is the case with man, in a state of idiocy or insanity, or when the organs are unusually active. It is only when the will is exercised, that our actions become morally free, and subject to merit or blame.

It is not the impulse that results from the activity of a single organ, or, as authors term it, the feeling of

* Vol. 11, on Moral Liberty.

a desire, that constitutes the will. That man might not be confined to desiring merely, but might will also, the concurrent action of many of the higher intellectual faculties, is required; motives must be weighed, compared, and judged. The decision resulting from this operation is called the *will*. There are as many kinds of desires, propensities and passions, as there are fundamental powers. There is but one will. The desires, propensities, and passions are the result of the action of isolated fundamental powers. The will is the result of the simultaneous action of the higher intellectual powers, and supposes attention, reflection, comparison, and judgment. The will is often in direct opposition to the desires, propensities and passions. *Cæteris paribus*, the desires and passions will prevail in a rough, uncultivated man; the will will triumph in the refined and educated man. The brute, the violently excited man, the idiot, and the maniac, have ardent desires and passions, but hardly any will. The actions of those who are solely guided by the desires and passions, are easy to foresee, and calculate, however little we may know of their organization. The decisions of the will, however, cannot be foreseen with much certainty, but by means of a profound examination of the nature of all the motives, which are furnished in part by the organization, and in part by the external world; by circumstances of convenience, morality, religion, legislation, social order, and the good of society. These remarks are sufficient to establish the difference between the desires, propensities, passions, and the will, or liberty; and to convince the reader, that there can exist no particular organ of the will, or free-will.

As little ground is there for the existence of a particular organ of the will, or of free-will. Every fundamental faculty accompanied by a clear notion of its existence, and by reflection, is intellect, or intelligence. Each individual intelligence, therefore, has its proper organ; but reason supposes the concerted

action of the higher faculties. It is the judgment pronounced by the higher intellectual faculties. A single one of these, however, could not constitute reason, which is the complement, the result of the simultaneous action of all the intellectual faculties. It is *reason* that distinguishes man from the brute; intellect, they have often in common, to a certain degree. There are many intelligent men, but few reasoning ones. Nature produces an intelligent man; a happy organization cultivated by experience and reflection, forms the reasoning man. As will and reason suppose the existence of fundamental powers, and as the latter are founded in organization, it is obvious, as I have already proved by other arguments, in the section on innate dispositions, that will and reason themselves are not indefinite powers, independent of organization, and consequently, that there cannot be such a thing as unlimited, and absolute liberty. It is clear too, that, by reason of his nobler organization, man is susceptible of moral motives, which he can weigh, compare, and judge; that the comparison made, and the judgment given, he is permitted to determine in consequence, or, in other words, that he is endowed with moral liberty; that consequently, his actions are meritorious or blameable — moral or immoral.

Can we find Organs for the Affections?

Most authors confound the affections with the passions. By passion, I mean the highest degree of voluntary or involuntary activity, of which any fundamental power is susceptible. Each passion supposes a particular organ, which produces passion, as its function, only when in its maximum of activity. It is altogether different with the affections. In the passions, the organs are active, exalted in their fundamental function. In the affections, on the contrary,

the organs are passive, they are modified,—struck, in a particular manner, agreeably or disagreeably. Modesty, terror, anguish, sadness, despair, jealousy, anger, joy, ecstasy, &c., are involuntary sensations, passive emotions, either of a single organ, or of the whole brain.

There cannot be a particular organ for joy, or sadness, or despair, or discouragement, or hope, or any affection whatever. To admit one, would be equivalent to admitting a particular nerve for pain, and a particular nerve for agreeable sensations. Every nerve may be the seat of pain and of pleasure. If we admit a single organ for all the affections, it would follow, that every animal susceptible of one affection, would be susceptible of all, and that this organ, once set in action, all the affections, however unlike or opposite they may be, would simultaneously affect both man and brute.

Conclusion.

These views of the qualities and faculties of man are not the fruit of subtle reasonings. They bear not the impress of the age in which they originate, and will not wear out with it. They are the result of numberless observations; and will be immutable and eternal, like the facts that have been observed, and the fundamental powers, which these facts force us to admit. They are not only founded on principles deduced from individual facts, but are confirmed by each individual fact in particular, and will for ever come off triumphant, from every test to which they may be submitted, whether of analysis or synthesis. If the reasonings of metaphysicians are ever discarded, this philosophy of the human qualities and faculties, will be the foundation of all philosophy in time to come.

Division of the Moral Qualities and Intellectual Faculties.

The moral qualities and intellectual faculties may be differently divided, if considered in a different point of view. We may divide them into sentiments, propensities, talents, and intellectual faculties. Pride and vanity, for instance, would be sentiments; the instinct of propagation and the love of offspring, propensities; music and mechanics, talents; and comparative sagacity, an intellectual faculty. It is often perplexing, however, to fix the precise limits of each division. The intellectual faculties and talents, when their organs are very active, are manifested in company with desires, propensities and passions; and the sentiments and propensities have also their judgment, taste, imagination, and memory.

The division into qualities and faculties which are common to man and brutes, and qualities and faculties exclusively possessed by man, is very valuable, I acknowledge, in a philosophical point of view. But since there are naturalists who think they perceive in some brutes, certain monkeys for example, an idea of justice and injustice, and even a sentiment of the existence of God, and since the more cautious observer would not venture to decide where the faculties of the brute end, and those of man begin, it must be acknowledged, that this division would not be generally satisfactory.

The best division appears to me to be that of fundamental qualities and faculties, and that of the general attributes of these same qualities and faculties. We thus preserve, and profit by the fruits of my predecessors' labors, while we establish the true theory of the primitive and fundamental instincts, qualities, and faculties of man and brutes. These two divisions have just been discussed. In order to complete my work, I now proceed to present to my

readers some propositions of the highest importance, whose solution directly depends on the physiology of the brain.

What are the Motives of our Actions?

So long as the philosopher, the moralist, the judge, and the legislator have not a minute acquaintance with the springs of our actions, their interpretations, their imputations, their decisions, and their laws, will always be wrong. Hitherto nearly all writers have considered self-love or interest, as being the sole motive of our desires, and the will, as the sole agent in determining our actions. It is evident, however, that there must be as many motives to action, as there are primitive qualities and faculties. Here too the comparison of man with the brutes, will be of great utility. The actions of the brutes are simple, free, and exempt from all doubtful interpretation; while those of men, on the contrary, are almost always more or less complicated, and the individual himself is, very often, unable to render a reason for them. Their motives are doubtful, and never entirely free from capricious subterfuges. The most powerful springs of the actions of brutes, are the instincts of propagation, of love of offspring, of attachment, of self-defence, of the sentiment of property, &c. Their actions are very often determined by envy, jealousy, hatred, anger, cruelty, and benevolence. Surely no philosopher can pretend to have indicated the motives of animals, by attributing them to interest, self-love, or, the sole desire of self-preservation. Man being endowed and governed by the same desires, the same propensities, the same passions, and the same affections, his actions must be determined by the same motives. Our social, civil, and religious institutions are due, in a great measure, to the instincts of propagation, of love of offspring, of self-defence, of the sentiment of

property, of vanity, ambition, the desire of independence and domination.

We have only to call to mind my observations on each organ, and its sphere of activity, to have a general view of the natural history of the moral man. I have given the reasons, why one person applies himself to the arts and sciences, while another finds his happiness in sloth and ignorance; why every one, from the Brahmin to the cannibal, from the slave to the despot, from the most superstitious devotee to the most arrogant infidel, believes himself possessed of excellent motives for his belief and conduct. Excite the fundamental qualities and faculties till they act with energy, and you will then see the motives of all the extravagances of passion, of all the wonders of genius, and of all the efforts of virtue and wickedness. Vary the age, sex, temperament, health, or nourishment, and you vary the action of the cerebral organs, and frequently, the desires, propensities, passions, and ultimately, the motives and determinations.

Thus far, the actions of men are scarcely less instinctive, than those of brutes. Knowing the qualities and faculties, and the degree of their activity, we can infer the motives; and the actions themselves, it is as easy to predict. The modest artist, under a thousand humiliations from the rich, will continue to cultivate the arts; the benevolent, after a long experience of ingratitude, will be always impelled to acts of beneficence; and the rash, crippled by wounds, will always rush into battle. Thus in most cases, man has less to do, in originating his actions, than nature. But give to him all his prerogatives, let him act with reason and will, from that moment he becomes a free moral agent. Whoever would wish to foresee or judge his actions, must not only know his natural disposition, but also all the external elements that concur in producing his determinations; for the acts of reason and will are often diametrically opposed to the instigations of the desires, wants, and passions.

It follows, as I have elsewhere remarked, that if you would always have actions to be the result of deliberate reason, you must cultivate the inward qualities and faculties; multiply, ennoble, and enforce the outward motives. It follows, too, that the virtues and crimes of men may as justly be imputed to those, who are charged with their education and government, as to those, who are themselves patterns of virtue or crime.

It is still objected, that all the qualities and faculties together constitute the *moi* of the individual; that every gratification of a desire, propensity, or passion, is connected with his interest and self-love; and consequently, that the motives of his actions are all resolved into interest, or self-love? I reply, that the philosopher's rage for abstracting and generalizing, has also generated this false theory, which considers all the moral qualities and intellectual faculties, as simple shades of the single, solitary principle, sensibility. As sensibility alone will not explain the phenomena of voluntary motion, the different functions of the five senses, the moral qualities and intellectual faculties, so neither are interest and self-love, considered as the sole motives of our actions, sufficient to account for instinctive acts, nor for the deliberate convictions of human reason.

Of the origin of the Arts and Sciences, and of different Communities.

The origin of the arts and sciences, and of different communities, is almost universally attributed to chance, necessity, or reflection. Even the earliest and most indispensable of human occupations, are derived from the same source. Hunting and fishing, it is said, were invented, because the spontaneous fruits of the earth were insufficient for the nourishment of families; and when families have become so numerous, as to form tribes and nations, they have been obliged to resort to

agriculture; the women and children not finding sufficient food, man is obliged to attach himself to one woman only, and to share with her in the domestic cares. Here is the origin of marriage, and of society, which goes on increasing in numbers, and giving rise to all the wants. The inclemency of the weather is to be guarded against, and thence spring the arts of making clothes, and building houses and palaces. Thence also, arise the factitious wants, all the desires and passions, which are the result of inequalities of condition, vanity, love of distinction, and glory, ambition, avarice, war, luxury, with the excesses it cherishes, laws, police, religion, the thirst for strong emotions, music, eloquence, poetry, and shows.

If outward accidental causes are the source of all these inventions, why have they not produced the same effects in the brutes? Why does not the dog build a house to protect him from the inclemencies of the weather? Why do the partridge and raven perish of cold, rather than migrate like the swallow? Why is it that each animal satisfies its wants in a manner peculiar to itself? that each man has different wants, though outward circumstances are very nearly the same in all? In treating of the fundamental powers of man and brute, I have satisfactorily answered these questions. The true source of the arts and sciences, is our innate instincts, propensities, and faculties — our inward wants.

Who invented the spider's web, the beaver's cabin, the hang-bird's nest, the bee's cells, the nightingale's song? Who suggested the idea of a republic to the ants, of tricks to the monkeys, of sentinels to the chamois, of migration to the storks, of hunting to the wolves, of provisions to the hamsters, of marriage to nearly all the birds, and a large part of the mammifera? All these things are universally attributed to instinct, to an inward impulse, never to external circumstances. The cause of these inventions, therefore, lies in the organs, or, in other words, animals

have received from nature, by means of organs, certain definite powers, propensities, talents, and faculties, which produce their habits, that have so often the appearance of spontaneous and deliberate actions. It is precisely the same with man. All that he does, or knows, all that he can do, or can learn, he owes to the author of his organization. God is its source; the cerebral organs, his intermediate instrument. The same organ, which in the nightingale produces singing; in the beaver, the faculty to build; in the hamster, the propensity to lay up provisions; produces in man, music, architecture, love of property. The poet, the orator, the legislator, the minister of religion, are the work of God. Chance may furnish a faculty, the occasion of displaying activity, but when the faculty does not exist, it accomplishes nothing. Pythagoras, passing by a blacksmith's shop, was struck with the gradations of the different sounds of the hammers. He examined them carefully, and made one of the most brilliant discoveries in acoustics, and one which has most contributed to the perfection of music. To Newton, the fall of an apple from the tree, was the occasion of discovering the laws of gravitation. How often has the sound of hammers been heard, and apples seen falling to the ground, without giving rise to the slightest presentiment, that these phenomena take place by virtue of certain laws of nature? I showed, while treating of each particular fundamental power, that oftentimes, the first *instinctive* efforts of genius are master-pieces. It is not until after he has constructed machines, and built houses, for ages together; spoken language, whether of words, or signs; cultivated painting, sculpture, music, poetry, eloquence, that man thinks of seeking for the rules of these arts, and of fixing their laws. During the same time, too, he has reasoned correctly, without inquiring for the rules of logic; he has compared, and judged, without suspecting that the flow of his ideas was confined to any necessary catenation.

He was a logician, long before he had learned any logic; and in the same way, he decided what was just, and what unjust, long before having any acquaintance with jurisprudence.

No valid objection to my reasoning can be drawn from those inventions or discoveries, which, like organology, or any branch of natural history, are, in fact, the fruit of accidental circumstances, and of the simultaneous action of several intellectual faculties — of combination, analysis, abstraction. These discoveries have not been made by any particular organ; they are the result of observation, of the faculty of ascertaining what individual phenomena have in common, of learning the laws of phenomena, and applying this knowledge to a specific object. The progressive improvement of inventions and discoveries, is not to be attributed to any particular power, but is the result of application and experience; the first invention is the work of genius. Neither let it be objected that, upon my principles, any man, supposing him to have lived under favorable circumstances, might have invented all the arts and sciences. A man of moderate powers — and of such is the majority of mankind — invents nothing, and creates nothing, of himself. His faculties only are competent to appropriate, what is already invented. It is only remarkably developed organs, whose activity is exercised on things without, that leave their impressions on the external world — that, in a word, create.

Banish music, poetry, painting, sculpture, architecture, all the arts and sciences, and let your Homers, Raphaels, Michael Angelos, Glucks, and Canovas, be forgotten; yet let men of genius of every description spring up, and poetry, music, painting, architecture, sculpture, and all the arts and sciences will again shine out in all their glory. Twice within the records of history, has the human race traversed the great circle of its entire destiny, and twice has the rudeness of barbarism been followed by a higher degree of refine-

ment. It is a great mistake, to suppose one people to have proceeded from another, on account of their conformity of manners, customs, and arts. The swallow of Paris builds its nest like the swallow of Vienna, but does it thence follow, that the former sprang from the latter? With the same causes, we have the same effects; with the same organization, we have the manifestation of the same powers.

Ferguson has very justly remarked, that, "if we may rely on the general observations contained in the last section, the literary, as well as mechanical arts, being a natural produce of the human mind, will rise spontaneously, wherever men are happily placed; and in certain nations, it is not more necessary to look abroad for the origin of literature, than it is for the suggestion of any of the pleasures or exercises, in which mankind, under a state of prosperity and freedom, are sufficiently inclined to indulge themselves.

"Ages are generally supposed to have borrowed from those, which went before them, and nations to have received their portion of learning, or of art, from abroad. The Romans are thought to have learned from the Greeks, and the moderns of Europe, from both. From a few examples of this sort, we learn to consider every science, or art, as derived, and admit of nothing original in the practice, or manners of any people. The Greek was a copy of the Egyptian, and even the Egyptian was an imitator, though we have lost sight of the model on which he was formed.

—"Painting, sculpture, and the other imitative arts, are as ancient as the human race; they are found to exist, whenever men are formed into societies; no individual, therefore, can claim the honor of being their inventor."

Thus God is every where the artist, and man only the instrument.

Is the Human Species capable of Indefinite Perfectibility?

This proposition includes two entirely different points of view. It may be asked, whether the species can ever lose or acquire any quality or faculty whatever? and whether the faculties and qualities inherent in our organization, are capable of a constantly and indefinitely progressive course of improvement? The reader must beware of confounding these two questions, both of which organology can answer.

Can the Human Species ever lose or acquire any Quality or Faculty whatever?

Man can manifest no other qualities or faculties than those, whose manifestation is provided for by material instruments, the number of which is definite. While the present creation lasts, the number of these material instruments will neither be increased nor diminished; so that the species can never lose nor acquire any faculty, whether good or bad. If some philosophers boast of the indefinite perfectibility of the human race, and, on the other hand, if some moralists deplore its constantly increasing depravity, their reveries must be attributed to the erroneous hypothesis, that the moral man is only the result of chance and outward circumstances; that, in short, he is a being capable of infinite modification, and is subject to no law of nature. The forms of crystals and of plants, have never varied since the creation, and never will vary. Just so invariable is the organization of the human race; consequently, his moral and intellectual character can experience no essential change.

In several parts of this work, I have refuted all the prevalent notions concerning the pretended influence

of the social life on the origin of the factitious qualities and faculties. Man can possess no artificial quality or faculty. He is designed, by his organization, like many species of animals, to live in society, and consequently, he must be provided with all the qualities and faculties, necessary to the maintenance of the social state. Communities are the result, not the cause of their moral qualities and intellectual faculties. Will it be said, that the republics, in which bees, ants, and beavers live, have produced the instincts of these beings? Is it not far more reasonable to believe, that their innate instincts have collected them into republics? If you hesitate to admit this opinion, form the foxes, tigers, and vultures into flocks, and show us a single artificial quality or faculty, which will result from their association. Where is the vice or crime, that sullied the memory of our forefathers, which no longer disgraces our own history? Where is the virtue, that adorned the early ages of the world, which is not also the boast of our own time? Read the ancient moralists and historians; the men of Horace, Homer, Lucan, Livy, and Socrates, are the men of Montaigne, La Bruyere, Voltaire, Bossuet, and La Rochefoucault. To maintain, that any virtue whatever has disappeared from the surface of the earth; that our times present fewer examples of generous forgiveness, of sacrifices to friendship, of heroic courage, of conjugal fidelity, of maternal love, of love of country, than the time of the Trojan war, would be as absurd, as to maintain that the sun has ceased to warm the earth, and the dew to refresh the fields; to maintain that cruel revenge, base perfidy, calumny, envy, perjury, servile adulation, false witness, espionage, ingratitude, thefts, murders, luxury, war, despotism, visit society with their desolations, less than in the time of Joshua and Nero, would be no less an error, than to believe that earthquakes, inundations, storms, and tempests, will no longer devastate our land.

Finally, what qualities would they derive from the civilized state? Is it property? I have proved, that the sentiment of property is innate, not only in the human species, but also in brutes. And in the same place, I have shown that the savages and barbarians of all times, have had their respective properties. Is it pride, ambition, vanity, love of gain? or is it certain talents? But the savage and the barbarian are vain and proud, and their principal concern is for dress and pleasure. They share all our vices, in the very bosom of the forests, and dispute with the inhabitants of cities for the palm of extravagance. Games, even those of hazard, also belong to the remotest times. The savage brings his furs, his tools, and his necklaces to the gaming table, and there he finds the excitement and agitation, which monotonous labor cannot furnish. While his fate is yet undecided, he tears out his hair, and strikes his breast with the fury of the most accomplished player, and often quits the game naked and stripped of every thing he possessed. In countries where slavery is the custom, he stakes his liberty for the single chance of regaining what he has lost. Is not this a faithful picture of the frequenters of our own gambling houses? In talents, savages and barbarians often surpass us. They frequently manifest a penetration, a force of imagination, and even of elocution, a warmth of soul, a courage, a constancy of affection, to which the arts, education, and politeness of the most cultivated nations, have nothing to add. If the object be to penetrate the thoughts and intentions of those, with whom they have to deal, their glance is piercing and sure. If they design to cheat or deceive, they veil their design with so much skill, that it is difficult for the most subtle person to escape their toils. In the public councils, their eloquence is figurative, nervous, and glowing with warmth, and in the negotiation of treaties, they show the most perfect discernment of their national interests. In times of peace their intercourse is friendly,

even in the rudest state, and they are affectionate to one another. An individual enjoys the greatest security, both in respect to his property and person. The principles of honor, generosity, and justice, are practised with an enthusiasm, equal to the violence with which at other moments, they practise revenge and cruelty.

Thus all the pretended factitious qualities and faculties, are an original possession of the human species, and not the subsequent effects of invention and discovery. It is in the dispositions of uncultivated men, of barbarians and savages, that we must study the natural dispositions of civilized nations. Thucydides, notwithstanding the prejudices of his country against every thing that bore the name of barbarian, was conscious, that the manners of ancient Greece were to be studied in the customs of these people. The inverse of the proposition is equally true. Study the propensities and faculties of civilized man, and you will know the propensities and faculties of savages and barbarians. The germs of all that man has ever done or ever will do, even of his political institutions, are enclosed in his organization, for time and circumstance to develope and ripen. All this is merely modification; the essence is and will be, always and every where, the same.

How far is the Human Species Perfectible?

The question then, is no longer, whether the human species may lose or acquire any quality or faculty whatever; but whether the qualities and faculties, inherent in this organization, are susceptible of a continually progressive improvement, or, whether nature has placed limits to their perfectibility.

The hope of a constantly increasing improvement of our species, is a pleasing and animating sentiment. But, alas! the laws of organization and the records of

history, destroy the illusions of the metaphysicians. The elephant and the whale, though infinitely larger than the mite: the cedar and the oak, infinitely taller as they are, than the moss, have still their prescribed dimensions. And will you pretend, in your presumptuous arrogance, that the organs of your brain will meet with no limits in their development and activity! It is idle, to object to me the distance between brutal ignorance and refined learning, — between the savage and the civilized man. We have seen that this distance is marked by no essential difference. Cast a careful look at the various conditions of the human family, even in the civilized, and you will see depicted with equal fidelity, both its littleness and its grandeur.

Surrounded as we are by refined and cultivated men, we readily attribute to mankind in general that progress and perfection, for which we are indebted to a few individuals. As long as we have had any knowledge of our race, the generality of men have been the slaves of ignorance, error, prejudice, and superstition. Slavery, brutality, and sensual gratifications of the grossest description have ever been the main features of his history. Even the hunters, fishermen, and tillers of the earth, have hardly possessed the knowledge necessary to their employments. Every thing is done mechanically; to deviate from the old routine, to alter, and improve, is to them, absurd, ridiculous, and criminal. Mechanics too are scarcely any better. The majority resemble automata, more than intelligent beings. Laborers, and, in short, all who are obliged to spend the most of their time in obtaining the necessaries of life, either do not think at all, or have but a few ideas relative to the satisfaction of their wants. Though encompassed by the wonders of nature, they are hardly touched by the melodies of birds, or the beautiful tints of flowers; the changing seasons, the meteors with all their diversified and striking appearances, even the majestic spectacle of the

stars, never excite their curiosity, and scarcely ever arouse their minds from indifference and supineness.

Let us pass to the higher classes. The influence of the heads of government on the prosperity or decline of the arts and sciences, we know, is incalculable. They are aware, that, in encouraging talents, they are embalming their own names; that though conquests astonish the world, the protection of industry draws upon themselves the blessings of ages. The immense range of their duties, and the tyranny of etiquette, scarcely allow them to devote a few moments to lighter and more pleasing cares. Too often, the jealousy and ignorance of favorites inspire them with mistrust of the men, who attack with superior power the abuses and weaknesses of their time; and the most generous and beneficent efforts of genius, instead of being welcomed, if not completely crushed, are at least hampered and checked.

They who vegetate in lazy opulence, are content with suing for office and distinction, with decorating themselves with medals and ribbons, and dissipating their whole life in sensual pleasures. Their fortune and influence dispense with the necessity of reflection and form the propensity to idleness, so natural to the majority of mankind. Hence it is that pomp and ignorance are as inseparable, as dissipation and misery; hence the sad truth, that the class, which from their imaginary elevation, looks down on the people with disdain, is moreover, in point of intelligence, on the same level with them. There is the same indifference, the same prejudice, and the same aversion towards new truths; the same tenacious adherence to old errors, the same credulity and the same superstition. The fatidical flight of birds, the fatidical oaks of the forest of Dodona, the sorceress of Thessaly, the magic of Egypt, the oracles of Delphos are replaced by fortune-tellers, prophets, interpreters of dreams, presentiments and inspiration, hobgoblins, ghosts, and unlucky days and numbers. We still live with Romans

and Spartans, who seek to know the future, in the motions of the bills of birds, and in the entrails of beasts; we have yet our Mithridates and Alexander, who employ conjurers to interpret their dreams. Penetration and prudence and great military and political talents, and the height of civilization, are as incompetent now, as they ever were, to guard ignorance from the most puerile, absurd, and superstitious practices. Can those even, who are led by the energy of their faculties to reflection and the search for truth, fortify their minds against error? Can they save themselves from the wildest extravagances? The fatalism of Zeno, and the absolute, indefinite liberty of Ancillon; the Iroquois notion of the immortality of brutes, and that of Descartes of their automatic nature; the doctrine of Parmenides, that God includes all ideas, and that of Malebranche who saw all things in God; the belief of Empedocles in the transmigration of souls; the numbers of Pythagoras, which the Supreme Intelligence used for direction in the creation of the world; the blank table of Helvetius; the doctrine of Lucretius, which attributes the creation of the universe to the concourse of atoms; Berkeley's disbelief in the existence of matter; the molecules of Buffon; the monads of Leibnitz; the atoms and the voids of Leucippus and Democritus; the approval of suicide and contempt of all property, of Antisthenes and Diogenes; the voluntary sufferings and abstinence of Epictetus; the merry philosophy of Aristippus and Epicurus, &c. &c., are but specimens of the efforts of philosophers, most of whom were the admiration of their age.

We need not speak of the interminable, and often bloody, controversies of theology, the eternal vacillation of the forms of government, of the present infancy of criminal legislation, of the fluctuation of the principles of civil law; the disputes relative to national law, supported, as they always are, by force and violence; let us look where we might have some grounds to expect indefinite perfection. Compare with modern

works of art, the temple of Dendera in Egypt, the Pantheon at Rome, the temple of Nîmes in France, the vast temple at Heliopolis in Syria, now Balbec, the immense circus at Rome, the arenas in the city of Nîmes, the theatre of Marcellus at Rome, Trajan's column, the Antonine column, a vast temple at Pœstum, the temples of Pola in Istria, the ruins of Thebes, of Sienna, of Persepolis, and, most astonishing of all, those of Palmyra, the Baths of Titus and Caracalla, and the excavations of Herculaneum and Pompeii. Compare the poets, painters, and orators of our days, with Homer, Virgil, Horace, Ovid, Tasso, Cicero, Michael Angelo, and Raphael, and then maintain, if we can, that the productions of the mind are always progressing in improvement.

All that man can immediately attain by the force of his powers; all that is the result of great genius, he has and will attain, whenever favored by nature with a large development of his organs. But, where the progress of the arts and sciences, requires a particular concurrence of fortunate circumstances and combinations, it is impossible to fix a limit to our knowledge. The positive arts and sciences, geometry, astronomy, experimental physics, navigation, chemistry, anatomy, surgery, medicine, agriculture, natural history, bear no resemblance to their former condition. Still, since our capacities are always limited, we necessarily lose as many old ideas as we obtain new ones, and when the mass of society shall be enriched by innumerable discoveries, individuals will no longer be astonished. Every one is obliged to confine himself to a particular sphere, to make ever so little of his privileges, and scarcely has he begun to flutter on the height of his domain, when he is precipitated into the abyss of nothing. We see nations remaining for thousands of years stationary in mediocrity, and none have gradually risen for any length of time, towards moral and intellectual perfection. Athens and Rome have sunk into barbarism, and the flux and reflux of the ocean every where represent the history of human affairs.

Philosophers have always drawn an argument in favor of the indefinite perfectibility of our species, from the uniformity of the actions of brutes. But the sum of men's dispositions, and consequently their principal actions, are every where alike. People the most remote in time and place, are united together in their interests and institutions. We deceive ourselves when we consider the maxims of the present day, as the results of modern reflection and experience. The morality of Pythagoras, of Socrates, and of Christ, are all equally founded on the sentiment of benevolence, and the good of society. Even savage nations, have presented perfect models of our civil and political institutions. At the time of the first settlement of Europeans in America, the six nations of North America were leagued together, and had their States-general. The stability of their union, and the wisdom of their conduct gave them an ascendancy over the whole population between the mouths of the St. Lawrence and the Mississippi. They showed themselves as well acquainted with the interests of the confederation, as with those of separate nations, and studied to maintain the balance between them. The representative of each nation watched the designs and movements of the rest, and neglected no opportunity of increasing the influence of his tribe. They made alliances, and treaties, like European nations, which they respected or violated from reasons of state. A sense of necessity, or considerations of utility, kept them in peace; while jealousy, or any other cause of rupture, made them resume their arms.

Thus, without any fixed form of government, and in a way, with which instinct had more to do than reason, they were guided by the same maxims, as modern government. The conclusion is—and it is supported by all the observers of our race—that the history of all nations, from their savage state to their highest pitch of civilization, is perfectly alike.

Finally, when I see the greater number of people

despising the arts and sciences, and with all the arrogance of ostentation and power, consuming all their powers in commercial pursuits, or sensual enjoyments; when I see the proneness of men to sloth, and the commonest ideas, and their invincible aversion to every mental effort, and innovation; when in travelling among people styling themselves the most cultivated in the world, I find at every step, entire provinces still plunged in barbarism, and see that the same men not only bear with indifference the vilest condition, but shrink from whatever would point them to a lot worthy of humanity; when history teaches us that sometimes, nations which have risen to the summit of distinction, relax their efforts, and that after a few ages of light and knowledge, either in consequence of their own sloth, or the jealousy of their neighbours, they again find themselves in the depths of ignorance and barbarism, — who, after such reflections, can help maintaining, that the moral perfectibility of the human species is confined within the limits of his organization.

What is the World of Man, and of the different Species of Animals.

The natural history of instincts, of industrious habits, propensities, and faculties, and the demonstration of their organs, necessarily leads to the conclusion, that the moral and intellectual world of man and the brutes, begins where the brain begins, and ends, where the brain ends. The following considerations raise this assertion to the rank of an incontestable truth.

Inanimate bodies are unconscious of their existence. They have no *moi*; nothing tells them that they are individuals independent of other beings, and alone, though infinitely multiplied, they would constitute a perfectly dead nature. Life, *moi*, consciousness of

the existence of the world, begins with sensation, with the nervous apparatus. When the individual perceives, that it is distinct from surrounding things, it has a *moi* whose capacity will be in proportion to the variety and intensity of its sensations; and consequently, to the number and energy of the organs of internal sensibility, and external relations. The more numerous the organs in contact with external objects, the more extensive will be the world of the animal. To the general, vague, indefinite sensation, add sensations that are determinate and essentially distinct from one another, and you gradually modify and enlarge its world. Each sense, each organ, becomes a new revelation. Taste, smell, hearing, vision, touch, each make known to him existences, and different relations of the world, and whether wholly or partially combined, the aspect of this world must essentially vary. Applying these remarks to the organs of the moral qualities and intellectual faculties, we may consider them to be also so many points of contact with the external world; so many sources of new kinds of sensations, sentiments, instincts, propensities, and faculties; but we have seen, that they are unequally shared by the different species of brutes. Their internal and external world must therefore vary to infinity; diminishing or increasing in the same proportion, as the number of these organs diminishes or increases.

What a difference between two beings, one of which, scarcely higher than the plants, and nearly unconscious of its existence, is generated from their decay; and the other which is led to the propagation of its species, by the warmest desires, and the most exquisite enjoyment! Give to these beings the love of offspring, and this organ becomes an inexhaustible source of the tenderest feelings, the dearest cares, and the most anxious solicitude. From this moment, the whole existence of the man and woman, of the male and female, seems to be in reference to these two

powerful instincts. Destroy these two organs, and, though all the rest remain, the interest and charm of life are destroyed. The delights of the marriage state, and the sweets of friendship and social intercourse, we owe to a cerebral part. By means of a cerebral organ too, the Creator has inspired us with the right and the duty of defending ourselves, our children, friends, property, and country, against the assaults of enemies. Without this and the organ of the carnivorous instinct, the economy of man and animals, would be totally changed. Now, what an effort is here to seize the prey; there, to escape from the murderous tooth! War especially gives a form and object to communities. The necessity of public defence assembles together the most different men, and opens an immense range to the moral and intellectual powers. What scenes in the life of individuals, as well as in the history of nations, have these organs produced, and are, every moment, producing!

Cunning, craft, finesse, tact, prudence, sometimes the safe-guard of the weak, at others, the instrument of the strong, owe their manœuvres and intrigues to the same organ, as that to which the fox owes the fortunate issue of his nocturnal expeditions.

Remove another cerebral part, and you deliver men from the propensity to theft, but at the same time, destroy a great part of our social institutions. By rendering us indifferent to property, you take away one of the most powerful motives for our actions; the arts and talents would soon be sacrificed to idleness and indifference.

Were there no organ to assign to each animal a suitable place of abode, what confusion would result! This organ preserves the balance in the distribution of the animal kingdom, and peoples the plains and the mountains, the fields and the forests, the air and the water.

If man is deeply impressed with a sense of his own value; if he rises above his fellows; if he breaks

the chains of slavery; if he arrogates supreme authority, and thus gives rise to governments, think not this to be the work of man. It is the author of all things, who, by means of a particular organ, has subjected the human species to this arrangement.

The pleasure you find in pretended distinctions, the delicious reveries of those, who are seeking for honors, — this spring of such indefatigable activity, also comes from a cerebral part. What an amount of enjoyment and care, what an abundant source of follies and noble deeds, would be taken away, the moment the functions of this organ should cease!

Without circumspection, neither man nor brutes would be guarded against the dangers of inconsiderate and precipitate conduct; they would never carry their thoughts to the future, nor would they perceive the obstacles or perils of an enterprise.

What power renders man and brutes attentive to the events, that are passing around them, and teaches them to turn their propensities and faculties to account, under the circumstances in which they are placed? Take away the organ of educability, and brutes would cease to be useful to man; agriculture and civilization would be impossible; all our faculties and propensities would be confined to a narrow, determinate sphere of action, and man, like the brute, would be the slave of his propensities.

The organ of the sense of locality, every year, preserves, by means of migration, half of the animal kingdom from inevitable death. Man, under the impulse of this organ, traverses lands, and seas, and worlds. Without this organ, how much less knowledge, resources, and objects of admiration, should we possess!

Take away for a moment, the organs of painting, music, architecture, design, and sculpture, and we should no longer have the chefs-d'œuvre of Raphael, of Mozart, of Michael Angelo, of Canova, and of Homer.

The superficial observer never suspects, that he also

owes the faculty of communicating his thoughts, and transmitting them by articulate language, to a particular cerebral organ.

You congratulate yourself on being the friend of justice; your moral sense inspires you with high conceptions of your own nature; and your benevolence charms you. Yet, without a particular organ, all your glory, and all those fine emotions would be absolutely impossible.

Would you know why the brute never rises above earthly things; why he never sees the relation of cause and effect; why he does not know and adore the supreme intelligence? Learn how God has formed man. Follow step by step the eternal laws of the gradation of nature. There is no power without its organ, and new organs, give new powers. Now place man before you, and contemplate his high and prominent forehead; compare that majestic forehead with the depressed forehead of other creatures, and you will learn why man *is* man. Against this forehead are placed those organs, that bestow on him the human character, and by means of which, he penetrates the relations of causes and effects, and is made capable of will and reason. Place your hand on the front and top of his head, and you will there find the sign of the alliance, which his Creator has concluded with him. There is the organ, which has been commissioned to reveal to all nations the Supreme Intelligence, — the organ, which, enthroned in the noblest organization on earth, has always exercised, and will always exercise, supremacy over all human interests.

The world of each species of animals, is therefore the sum total of their cerebral organs — the sum of the relations, or points of contact between external things and internal organs. Where there is no organ, there is no relation, nor revelation. The turtle can never rise to the instincts of the elephant, nor the elephant conceive of the intelligence of man; and man having received no organ for conceiving of the infinity

of worlds, of the eternal duration, or beginning of things, or understanding the essence of God, is condemned to absolute ignorance of these mysteries. Let those who presume to compare themselves, so to speak, with the Divinity, to understand and explain the laws that govern the universe; and those, who, with vain-glorious boasting, believe they may dispense with the necessity of a supreme and independent Intelligence, remember, that all the material conditions of their thoughts and conceptions, are compressed within the compass of twenty-two inches. On the other hand, let us call to mind the industrious habits, instincts, propensities, sentiments, and faculties, which from the insect to man, characterize and diversify the immense multitude of animal beings, and, overwhelmed with feelings of adoration, prostrate ourselves before the Creator, who has transformed such slight materials into the instruments of such sublime and numerous powers! Are we to cast a stone at the physiologist, who, in the height of his astonishment, exclaims; *God and the brain! nothing but God and the brain!*

Moral Precepts resulting from the Physiology of the Brain.

The world, so far as knowledge is acquired by the external senses, must necessarily be modified in as many ways, as the senses themselves are modified. The wolf scents differently from the sheep; the eyes of the owl are affected by the light differently from those of the eagle. When the wolf, sheep, owl, and eagle, decide on the nature of effluvia and light, their judgments, though different, will be equally true, since they are all in accordance with the sensations produced on each, by light and effluvia. But the senses and their functions, are not only differently modified in different species, but also in the different individu-

als of the same species. The dish that is a dainty to you, may be loathed by me. Your hotch-potch may be an abomination to me. Still, no one thinks himself authorized to blame others for this difference in their tastes. There are many more reasons, why we should pardon the difference, and often opposition, of our propensities, sentiments, and faculties. What an immense variety in the development, excitability, and relative proportions, of our cerebral organs! Each individual, in himself considered, that is, independently of external influences, is marked by his own peculiar moral and intellectual character, and, placed in contact with the external world, receives his own impressions, and sensations. Consequently, the propensities, sentiments, and judgments of each individual, and the actions, that result from them, must differ from the propensities, sentiments, judgments, and actions of other individuals. This is why every body has reason to consider the criticism of others unjust, and it is doing violence to a natural law, to require the propensities, faculties, judgments, and actions of others, to accord with our views of things. Each has his personal rights, and unlimited toleration for every thing, that does not disturb the order of society, is the first, most sacred, and most philosophical duty. Here again is a proof, that he who discovers and publishes new physical truths, ought not to be afraid of contradicting moral truths.

Conclusion, and Summary Review.

Here, then, terminates this work, which, for fifteen years, the learned have been impatiently expecting. I should have wished to defer it still longer, to bring the fruits of my researches to greater maturity; but the final hour draws near, and I must be content with leaving this first effort in the physiology of the brain, far less perfect than it will be fifty years hence. I have

several times mentioned, how many means I have as yet failed to obtain, for positively demonstrating the results of my labors. It needs infinitely more materials to convince others, who, for the most part, are but little accustomed to observation, than, to convince one's self.

In order to put my successors on the proper track for improving my system, I have made a long list of questions, that remain to be answered, and I intend to devote a particular chapter to points, of which we are yet ignorant, but which it is indispensable for us to know. But, I am afraid of daunting young naturalists, who would shrink from too formidable an array of difficulties, when, otherwise, they would begin with courage, and remove one obstacle after another.

I regret, and always have regretted, that I dare not flatter myself, that my undertaking will ever be continued in all its details, or, that my exertions will be appreciated. Whoever is not impelled by an innate instinct of observation; whoever finds it hard to sacrifice his opinions, and the views he has derived from his earlier studies; whoever thinks more of making his fortune, than of exploring the treasures of nature; whoever is not fortified by inexhaustible patience, against the interpretations of envy, jealousy, hypocrisy, ignorance, apathy, and indifference; whoever thinks too highly of the force and correctness of his reasoning, to submit it to the test of experience, a thousand times repeated, will never do much towards perfecting the physiology of the brain. Yet, these are the only means, by which my discoveries can be verified, corrected, or refuted. The reader will pardon me, if, independently of the proofs of organology, which I have furnished, in treating of the fundamental powers, I also rely on experiments made in the presence of a great many persons, who accompanied us in our visits to prisons, &c.; for, I would neglect nothing, that might encourage the learned to study the functions of the different cerebral parts. The following is a translation

of an authentic account of my visits to the prisons of Berlin, and Spandau, inserted in Nos. 97 and 98 of the *Frey müthige*, May, 1805. Demangeon has given it in his *Physiologie Intellectuelle*, Paris, 1806.

"Dr. Gall having expressed a desire to inspect the prisons of Berlin, with the view of making himself acquainted with their arrangements and construction, as well as of observing the heads of the prisoners, it was proposed to him, that he should visit not only the prisons of that city, but the house of correction, and the fortress of Spandau.

"Accordingly, on the 17th of April, 1805, Dr. Gall began with those of Berlin, in presence of the directing commissaries, the superior officers of the establishment, the inquisitors of the criminal deputation, the counsellor Thürnagel, and Schmidt, the assessors Muhlberg, and Wunder, the superior counsellor of the medical inspection, Welper, Dr. Flemming, Professor Wildenow, and several other gentlemen.

"As soon as Dr. Gall had satisfied himself in regard to the regulations and general management of the establishment, the party went to the criminal prisons, and to the *salles de travail*, where they found about 200 prisoners, whom Dr. Gall was allowed to examine, without a word being said to him, either of their crimes, or of their characters.

"It may here be remarked, that the great proportion of those detained in the criminal prisons, are robbers or thieves; and, therefore, it was to be expected, that if Dr. Gall's doctrine were true, the organ of Acquisitiveness should, as a general rule, be found to predominate in these individuals. This accordingly soon appeared to be the case. The heads of all the thieves resembled each other more or less in shape. All of them presented a width and prominence at that part of the temple, where the organ is situated, with a depression above the eyebrows, a retreating forehead, and the skull flattened towards the top. These peculiarities were perceptible at a single glance; but the

touch rendered still more striking, the difference between the form of the skulls of robbers, and that of the skulls of those, who were detained for other causes. The peculiar shape of the head, generally characteristic of thieves, astonished the party still more, when several prisoners were ranged in a line; but it was never so strikingly borne out and illustrated as when, at the request of Dr. Gall, all the youths from 12 to 15 years of age, who were confined for theft, were collected together; their heads presented so very nearly the same configuration, that they might easily have passed for the offspring of the same stock.

"It was with great ease, that Dr. Gall distinguished confirmed thieves, from those who were less dangerous; and, in every instance, his opinion was found to agree with the result of the legal interrogatories. The heads in which Acquisitiveness was most predominant, were that of Columbus, and, among the children, that of the little H., whom Gall recommended to keep in confinement for life, as utterly incorrigible. Judging from the judicial proceedings, both had manifested an extraordinary disposition for thieving.

"In entering one of the prisons, where all the women presented a predominance of the same organ, except one, (then busy at the same employment, and in precisely the same dress as the offenders,) Dr. Gall asked, as soon as he perceived her, why that person was there, seeing that her head presented no appearance indicative of any propensity to steal. He was then told, that she was not a criminal, but the inspectress of works. In the same way, he distinguished other individuals confined for different causes besides theft.

"Several opportunities of seeing Acquisitiveness, combined with other largely-developed organs, presented themselves. In one prisoner, it was joined with Benevolence, and the organ of Theosophy, the latter particularly large. This individual was put to the proof, and, in all his discourses, showed great

horror at robberies accompanied with violence, and manifested much respect for religion. He was asked, which he thought the worse action, to ruin a poor laborer by taking his all, or to steal from a church without harming any one? He replied, that it was too revolting to rob a church, and that he could never summon resolution enough to do it.

"Dr. Gall was requested to examine particularly the heads of the prisoners implicated in the murder of a Jewess, which had taken place the preceding year. In the principal murderer, Marcus Hirsch, he found a head, which, besides indicating very depraved dispositions, presented nothing remarkable, except a very great development of the organ of Perseverance. His accomplice, Jeanette Marcus, had an extremely vicious conformation of brain, the organ which leads to theft being greatly developed, as well as that of Destructiveness. He found in the female servants, Benkendorf and Babette, great want of circumspection; and, in the wife of Marcus Hirsch, a form of head altogether insignificant. All this was found to be in strict accordance with the respective characters of the prisoners, as ascertained by the legal proceedings.

"The prisoner Fritze, suspected of having killed his wife, and apparently guilty of that crime, although he still stoutly denied it, was next shown to Dr. Gall. The latter found the organs of Cunning, and Firmness, highly developed, — qualities, which his interrogator had found him manifest in the very highest degree.

"In the tailor Maschke, arrested for counterfeiting the legal coin, and whose genius for the mechanical arts was apparent in the execution of his crime, Gall found, without knowing for what he was confined, the organ of Constructiveness much developed, and a head so well organized, that he lamented several times the fate of that man. The truth is, that this Maschke was well known to possess great mechanical skill, and at the same time much kindness of heart.

"Scarcely had Dr. Gall advanced a few steps into

another prison, when he perceived the organ of Constructiveness equally developed in a man named Troppe, a shoemaker, who, without any teaching, applied himself to the making of watches, and other objects, by which he now lives. In examining him more nearly, Gall found also the organ of Imitation, generally remarkable in comedians, considerably developed;—a just observation, since the crime of Troppe was that of having extorted a considerable sum of money, under the feigned character of an officer of police. Gall observed to him, that he must assuredly have been fond of playing tricks in his youth, which he acknowledged. When Gall said to those about him, *'If that man had fallen in the way of comedians, he would have become an actor,'* Troppe, astonished at the exactness and precision with which Gall unveiled his disposition, told them that he had in fact been some time (six months) a member of a strolling company,—a circumstance which had not till then been discovered.

"In the head of the unhappy Heisig, who, in a state of intoxication, had stabbed his friend, Gall found a generally good conformation, with the exception of a very deficient Cautiousness, or great rashness. He remarked in several other prisoners the organs of Language, Color, and Mathematics, in perfect accordance with the manifestations; some of the first spoke several languages; those with large Color were fond of showy clothes, flowers, paintings, &c.; and those with Mathematics large, calculated easily from memory.

On Saturday, 20th April, the party went to Spandau. Among those who accompanied Dr. Gall, were the privy counsellor Hufeland; the counsellor of the chamber of justice, Albrecht; the privy counsellor Kols; the professor Reich, Dr. Meyer, and some others. At the house of correction, observations were made upon 270 heads, and, at the fortress, upon 200. Most of them were thieves and robbers, who presented more or less exactly the same form of head,

of which the prisons of Berlin had exhibited a model. Including the whole, the prisons of Berlin and of Spandau, had thus subjected to the examination of Dr. Gall, a total of about five hundred thieves, most of them guilty of repeated offences; and in all, it was easy to verify the form of brain, indicated by Gall as denoting this unhappy tendency, and to obtain the conviction, from the discourse of most of them, that they felt no remorse for their crimes, but, on the contrary, spoke of them with a sort of internal satisfaction.

"The morning was spent in examining the house of correction, and its inmates; the most remarkable of whom were submitted, in the hall of conference, to the particular observation of Dr. Gall, sometimes one by one, and sometimes several at once. The combination of other organs, with that of Acquisitiveness, was also noticed.

"In Kunisch, an infamous thief and robber, who had established himself as a master-carpenter at Berlin, and who, in concert with several accomplices, had committed a great number of thefts with '*effraction*' (burglary,) for which he had been shut up till he should be pardoned, Gall found, at the first glance, the organs of Mathematics, and of Constructiveness, with a good form of head in other respects, except that the organ of Acquisitiveness was exceedingly developed. Gall said on seeing him, '*Here is an artist, a mathematician, and a good head; it is a pity he should be here,*'—an observation remarkable for its accuracy, as Kunisch had shown so much talent for mechanics, that he was appointed inspector of the spinning machinery, the repairing of which was confided to him. Gall asked him if he knew arithmetic, to which he answered with a smile, '*How could I invent or construct a piece of work, without having previously calculated all the details?*'

"The head of an old woman, who was in prison for the second time for theft, presented a great develop-

ment of the organs of Acquisitiveness, Theosophy, and the Love of Offspring, especially the last. Upon being asked the cause of her detention, she answered, that she had stolen, but that she fell upon her knees every day, to thank her Creator for the favor she had received, in being brought to this house; that she saw in this dispensation, one of the clearest proofs of the wonderful ways of Providence, for she had nothing so much at heart as her children, whom it was impossible for her to educate properly; that since her imprisonment, they had been taken into the Orphan Hospital, where they were now receiving that education, which she had not had the means of giving them.

"Deficiency of Cautiousness was often joined to a great endowment of Acquisitiveness. This was particularly the case, in the woman Muller, whose head presented also a very remarkable development of the organ of ambition, (organ of Vanity,) which, according to Gall, degenerates into vanity in narrow-minded and ignorant persons. She was unwilling to acknowledge, that she was fond of dress, thinking that this was not in harmony with her present situation; but her companions insisted, that she had much vanity, and was careful about nothing but her dress.

"In the prisoner Albert, the organ of Pride was joined with that of Acquisitiveness. *'Is it not the case,'* said Gall to him, *'that you were always desirous of being the first, and of distinguishing yourself, as you used to do, when still a little boy? I am sure that, in all your sports, you then put yourself at the head.'* Albert confessed that it was so; and it is true, that he still distinguishes himself by the command, which he assumes over the other prisoners, and by his insubordination, to the degree that, when a soldier, he could not be constrained but by the severest punishments; and even now he generally escapes one punishment only to incur another.

"Here, as at Berlin, Gall distinguished at a glance, such prisoners as were not thieves. Among others brought before him, was Régine Dœring, an infanticide, imprisoned for life. This woman, different from the other infanticides, showed no repentance and no remorse for her crime, so that she entered the room with a tranquil and serene air. Gall immediately drew the attention of Dr. Spurzheim to this woman, by asking him, if she had not exactly the same form of head, and the same disposition to violence, as his gardener at Vienna, Mariandel, whose chief pleasure consisted in killing animals, and whose skull now serves at his lectures, as an example of the organ of Murder. This organ was found to be very largely developed in Régine Dœring, and the posterior part of the head, in the situation of the organ of Love of Offspring, was absolutely flattened. This was in exact accordance with the character of the culprit, in so far as her examination bore upon it; for, not only has she had several children, of whom she has always secretly got rid, but she lately exposed and murdered one of them, already four years old, which would have led her to the scaffold, if the proofs had not been in some respects vague and incomplete, and her judges on that account had not preferred sentencing her to imprisonment for life.

"One of the gentlemen present was a distinguished musician, upon whom Gall had incidentally pointed out one of the forms of development of the organ of Tune, which consists in a projection above the external angle of the eye. As soon as the prisoner, Kunow, appeared before him, '*Hold,*' said Gall; '*here is the other form in which the organ of Music shows itself; it is here, as in the head of Mozart, of a pyramidal shape, pointed upwards.*' Kunow immediately acknowledged, that he was passionately fond of music, that he had acquired it with facility; and the production of the jail register showed that he was as an amateur, that he had spent his fortune, and that latterly he

had had in view, to give lessons in music at Berlin. Gall asked what was his crime. It appeared, that he had spent his youth in debauchery, and had been condemned to imprisonment for an unnatural crime. Gall having examined his head, and found the organ of Propagation in enormous development, immediately exclaimed, '*C'est sa nuque qui l'a perdu ;*' — '*It is the nape of his neck, which has been his ruin.*' Then, carrying his hand upwards towards Cautiousness, which was exceedingly deficient, he added, '*Maudite légèreté*' — '*Unhappy instability.*'

"After dinner the party went to the fortress. Major de Beckendorf, the commandant, had the politeness to cause all the prisoners to be drawn up in line, to be presented to Dr. Gall. Here the organs of Cunning, and Acquisitiveness predominated, as in the other prisons. They were sometimes so strikingly apparent, that at a glance the thief might be distinguished from the other criminals. Raps, in whom the organ of Acquisitiveness was very conspicuous, attracted among others the notice of Gall, who discovered at the same time large organs of Murder and Benevolence. What makes the justness of these observations very remarkable is, that Raps strangled a woman whom he had robbed, and that on going away he untied the cord from compassion, and thus saved the poor woman's life after robbing her of her property. He then examined the young Brunnert, in whom he found the organs of Acquisitiveness, Locality, Constructiveness, and Pride, which were curiously verified in his history ; for Brunnert had committed several robberies ; had been confined in various prisons, from which he had escaped ; fixed himself nowhere ; deserted as a soldier ; underwent several castigations for insubordination ; and, having again rebelled against his superiors, was once more waiting his sentence. He was, besides, skilful in the mechanical arts, and showed some exquisitely finished works in pasteboard, which he had executed in a prison, a place very unfavorable to such talents.

"The organ of Mathematics was largely developed in some; and in each case, the power of calculation was found to correspond.

"Two peasants, father and son, mixed with the thieves, attracted notice from having quite different forms of head. Gall having examined them, found an enormous development of the organ of Pride, and said, '*These two have not wished to be ruled, but to rule themselves, and to withdraw from any thing like subordination.*' It was discovered, that the cause of their confinement was insolence to superiors.

"An old soldier, who was among the prisoners, had a very large organ of Acquisitiveness. It was, however, for insubordination, and not for theft, that he was confined in the fortress; but, on farther research, it appeared, that he had been punished several times in the regiment for having stolen."

These facts will not astonish the reader, who knows the means by which they were obtained.

Permit me to advert to a singular disposition manifested by many, Reil, for example, to attribute our discoveries to others. Spurzheim has, in several places, reclaimed our property, and I have done as much in respect to Sir E. Home, &c. The following passages, also quoted in Demangeon's work, will be serviceable to those, who have been unable to follow the chronological order of the successive discoveries in the structure of the brain.

"The worthy Reil" says Professor Bischoff, "who as a profound anatomist and judicious physiologist, has no need of my praise, rising above all narrow and selfish prejudices, has declared, 'that he has found more in Gall's dissections of the brain, than he could have believed it possible, for any one man to discover in his whole life.' Loder, who indisputably yields to no living anatomist, thus estimates the discoveries of Gall, in a friendly letter to my respectable friend, Professor Hufeland. 'Now that Gall has been at Halle, and I have had an opportunity, not only of

listening to his lectures, but also of dissecting with him, either alone or in the company of Reil and several others of my acquaintance, nine human brains and fourteen of brutes, I think I am both able and entitled to pronounce my opinion of his doctrines.

“I say then, that I agree with you in a great measure concerning organology, without, however, believing it to be at all contradictory to anatomy, being convinced that, in respect to its grounds and principles, it is true. There are still some particulars to be corrected, and the whole system is too much in its infancy to be explained as many take upon themselves to explain it. It is evident, notwithstanding, that very well marked faculties may be discovered by indications on the skull. The crania of Schinderhannes and six of his comrades, which Ackermann of Heidelberg lent me, presented a striking correspondence with the craniological indications of Gall. In the presence of S., with whom the little H., of Jena lived, who drowned herself in the Saale, after stealing several times, Gall gave such an exact description of the character of this girl, from an inspection of her skull (which I had secretly procured, and which no one knew I had), that S. was really amazed when I revealed the secret. There was no chance about this, and I may say the same of several other cases.

“The discoveries in the brain, made by Gall, are of the highest importance, and several of them are so obvious, that I cannot conceive, how, with good eyes, it is possible to overlook them. I speak particularly of the great ganglion of the brain (*corpora striata*), the passage of the pyramidal bodies into the crura of the brain and hemispheres, the bundles of the spinal marrow, the decussation of the fibres in the pyramidal and olivary bodies, the recurrent fibres of the cerebellum, the commissures of the nerves, the origin of the motor nerves of the eye, the trigemini, and the sixth pair. I pass over other things, which, though very reasonable, do not yet appear to be sufficiently proved

These discoveries alone, would be sufficient to render Gall's name immortal; they are the most important that have been made in anatomy, since that of the absorbent system. The unfolding the convolutions is a capital thing. What have we not a right to expect, from farther progress in a route thus opened! I am dissatisfied and ashamed of myself for having, like others, for thirty years, cut up some hundreds of brains, as we slice up cheese, and not perceived the forest by reason of the great number of trees. But what is the use of blushing and fretting? The best thing we can do is, to listen to the truth, and learn what we are ignorant of. I say, with Reil, that I have found more, than I deemed it possible for any one man to do in his whole life.

"I am unwilling as yet to publish any thing on the subject, because I am anxious to obtain the utmost weight of evidence, to indicate the steps that are proper to pursue, and perhaps even, add plates to illustrate the facts. With this object in view, I have already examined ten human brains, and shall examine as many more as I can get. I am desirous too of comparing the brains of wild and tame animals, and of birds and fishes; of injecting the minute vessels of the brain, preparing them with alcohol, acids, solution of corrosive sublimate, maceration, &c., and of committing my observations to writing. I hope soon therefore to publish such a work as you might expect of me.' Thus thought and wrote the estimable Loder. Thus judged a man who, for nearly thirty years, had devoted himself to anatomy. His conduct proves, that true greatness consists in recognising the merit of others, and acknowledging one's own errors for the sake of truth."

On page 143 of the same work, Hufeland, before commencing his criticisms, thus expresses himself. "It is with great pleasure, and much interest in the subject, that I have heard this estimable man (Gall) expound his new doctrine. I am fully convinced, that

it ought to be considered as one of the most remarkable phenomena of the eighteenth century, and one of the most important and boldest advances that have been made in the study of nature.

"One must see and hear, in order to learn that the man is entirely exempt from prejudice, charlatanism, deceit, and metaphysical reveries. Endowed with a rare spirit of observation, considerable penetration and powers of acute reasoning, identified, so to speak, with nature, and deriving confidence from his constant intercourse with her, he has collected a multitude of indications and phenomena, in organized beings, never before observed, or observed superficially. He has compared them ingeniously, found the relations that establish an analogy between them, has learned their signification, deduced consequences and established truths, so much the more precious for being invariably founded on experience, and flowing from nature herself. To this labor he is indebted for his views of the nature, relations and functions of the nervous system. He himself attributes his discoveries to the circumstance, that he has ingenuously and unreservedly yielded himself to nature, always following her through all her gradations, from the simplest to the most perfect results of her formative power. It is wrong therefore to give this doctrine, the name of a system, and judge it as such. True naturalists are not addicted to making systems. Their *coup d'œil* would not be so nice, if they started from a theoretical system, and facts would not always quadrate in so narrow a circle. Hence it is that Gall's doctrine neither is, nor can be, from the opinion he has expressed of it himself, any thing more than a collation of instructive natural phenomena, as yet partly consisting of fragments, the direct consequences of which he makes known."

Such is the judgment which some most respectable men have passed on the anatomy and physiology of the brain, as I explained them directly after my depart-

ure from Vienna, in 1805. As they have since been improved and expounded in the six volumes of this work, it will be sufficient to give the reader a summary review of my labors.

SUMMARY REVIEW.

In all my researches, my object has been to find out the laws of organization, and the functions of the nervous system in general, and of the brain in particular. The exposition of the nervous systems of the chest and abdomen, and of the spinal column, or of voluntary motion, has shown us the same laws, both as to their organization and purposes. The nervous fibres invariably originate from the gray substance, as their matrix, and finally expand on the surface. Whenever an essentially different function appears, there is invariably a particular nervous organization, or system, independent of the rest. I have demonstrated the same laws of organization in the brain. The cerebral nervous fibres all originate in the gray substance, and are successively reinforced by new masses of the gray substance. Many bundles of nervous fibres exist independently of one another, and all finally expand in a nervous membrane, either spread out, or rolled up in the form of convolutions. This uniformity of the laws of organization of all the nervous systems, leaves no doubt as to the correctness of the anatomical discoveries of the nervous systems in general, and of the brain in particular.

Having determined the functions of the nervous systems of the chest, abdomen, vertebral column, and the five senses, there still remains the great difficulty of determining the functions of the brain and its different parts. Before entering upon this essential part of my system, it was indisdispensably necessary to correct the common notions respecting the origin of the in-

instincts, industrious habits, propensities, and faculties. Hence, an entire section is devoted to prove, that all our moral and intellectual dispositions are innate, and that every manifestation of a moral quality or intellectual faculty, depends on organization. Now I would ask, what is this organization, this instrument of all the moral and intellectual functions? Is it the entire body? Is it temperament? Is it a single part of the body, and what part is it? I have established the fact by a great many proofs, negative and positive, and by refuting the most important objections, that the brain alone has the great prerogative of being the organ of the mind. From farther researches, on the degree of intelligence possessed by both man and brutes, we draw the conclusion, that the complexity of the brain of brutes is in proportion to that of their propensities and faculties; that the different regions of the brain are devoted to different classes of functions; and that finally, the brain of each species of animals, man included, is formed by the union of as many particular organs, as there are essentially distinct moral qualities and intellectual faculties.

The moral and intellectual dispositions are innate; their manifestation depends on organization; the brain is exclusively the organ of the mind; the brain is composed of as many particular and independent organs, as there are fundamental powers of the mind; — these four incontestable principles form the basis of the whole physiology of the brain.

These principles having been thoroughly established, it was necessary to inquire, how far the inspection of the form of the head, or cranium, presents a means of ascertaining the existence or absence, and the degree of development, of certain cerebral parts; and consequently the presence or absence, the weakness or energy of certain functions. It was necessary to indicate the means for ascertaining the functions of particular cerebral parts, or the seat of the organs, and finally, it was indispensable, to distinguish the primi-

tive fundamental qualities and faculties, from their general attributes.

After that I was enabled to introduce my readers into the sanctuary of the soul and the brain, and give the history of the discovery of each primitive moral and intellectual power, its natural history in a state of health and of disease, and numerous observations in support of the seat of its organ.

An examination of the forms of heads of different nations, a demonstration of the futility of physiognomy, a theory of natural language, or pathognomy, added new weight to preceeding truths.

The thorough development of the physiology of the brain, has unveiled the defects of the theories of philosophers, on the moral and intellectual powers of man, and has given rise to a philosophy of man founded on his organization, and consequently, the only one in harmony with nature.

Finally, I have discussed four propositions equally interesting to history and philosophy, concerning the motives of our actions, the origin of the arts and sciences, the perfectibility of the human species, and the capacity of the world of each living being, and I have shown, that the solution of all these questions, hitherto problematical, springs directly from the physiology of the brain.

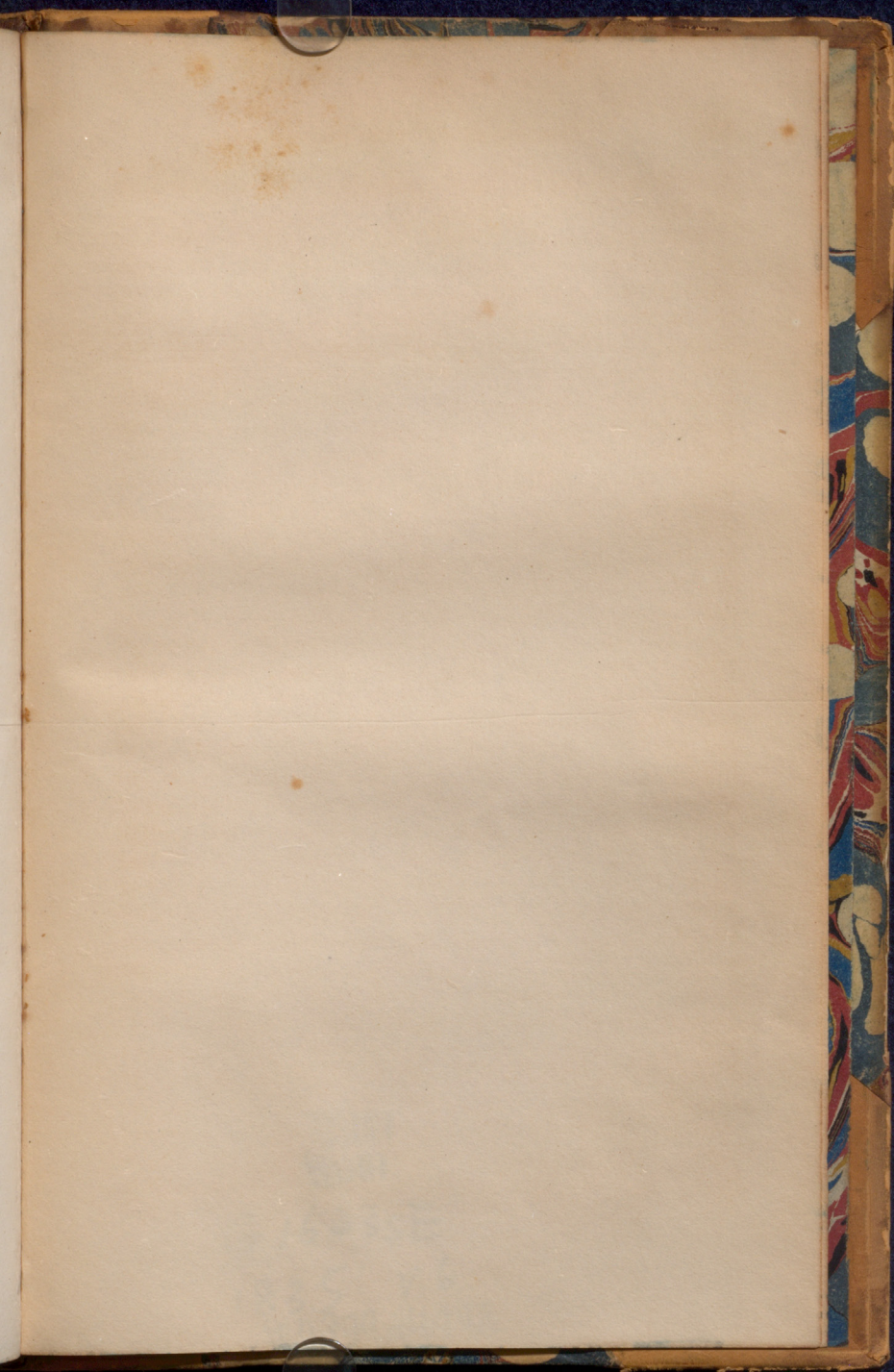
Many, and even well educated people, but knowing nothing of organology, except from common report, have asked me, with the most astonishing naïveté, if I really believe my own notions. It seems as if they supposed that I would be the first to be convinced of their error, but that I was desirous, either of enjoying the reputation of being the founder of an ingenious system, or of maintaining, from pride, opinions that had been hastily published.

If I were a man to be gratified with a little temporary eclat, I should have yielded, more than twenty years ago, to the desire of publishing the first views of a physiology of the brain, but I am prouder of the

discovery of the slightest truth, than the invention of the most brilliant system.

The physiology of the brain is entirely founded on observations, experiments, and researches for the thousandth time repeated, on man and brute animals. Here, reasoning has had nothing more to do with it, than to seize the results, and deduce the principles that flow from the facts; and therefore it is, that the numerous propositions, though often subversive of commonly received notions, are never opposed to or inconsistent with one another. All is connected and harmonious; every thing is mutually illustrated and confirmed. The explanation of the most abstruse phenomena of the moral and intellectual life of man and brutes, is no longer the sport of baseless theories; the most secret causes of the difference in the character of species, nations, sexes, and ages, from birth to decrepitude, are unfolded; mental derangement is no longer connected with a spiritualism that nothing can reach; man, finally, that inextricable being, is made known; organology composes and decomposes, piece by piece, his propensities and talents; it has fixed our ideas of his destiny, and the sphere of his activity; and it has become a fruitful source of the most important applications to medicine, philosophy, jurisprudence, education, history, &c. Surely, these are so many guarantees of the truth of the physiology of the brain — so many titles of gratitude to HIM, who has made them known to me!

END OF THE SIXTH VOLUME.





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